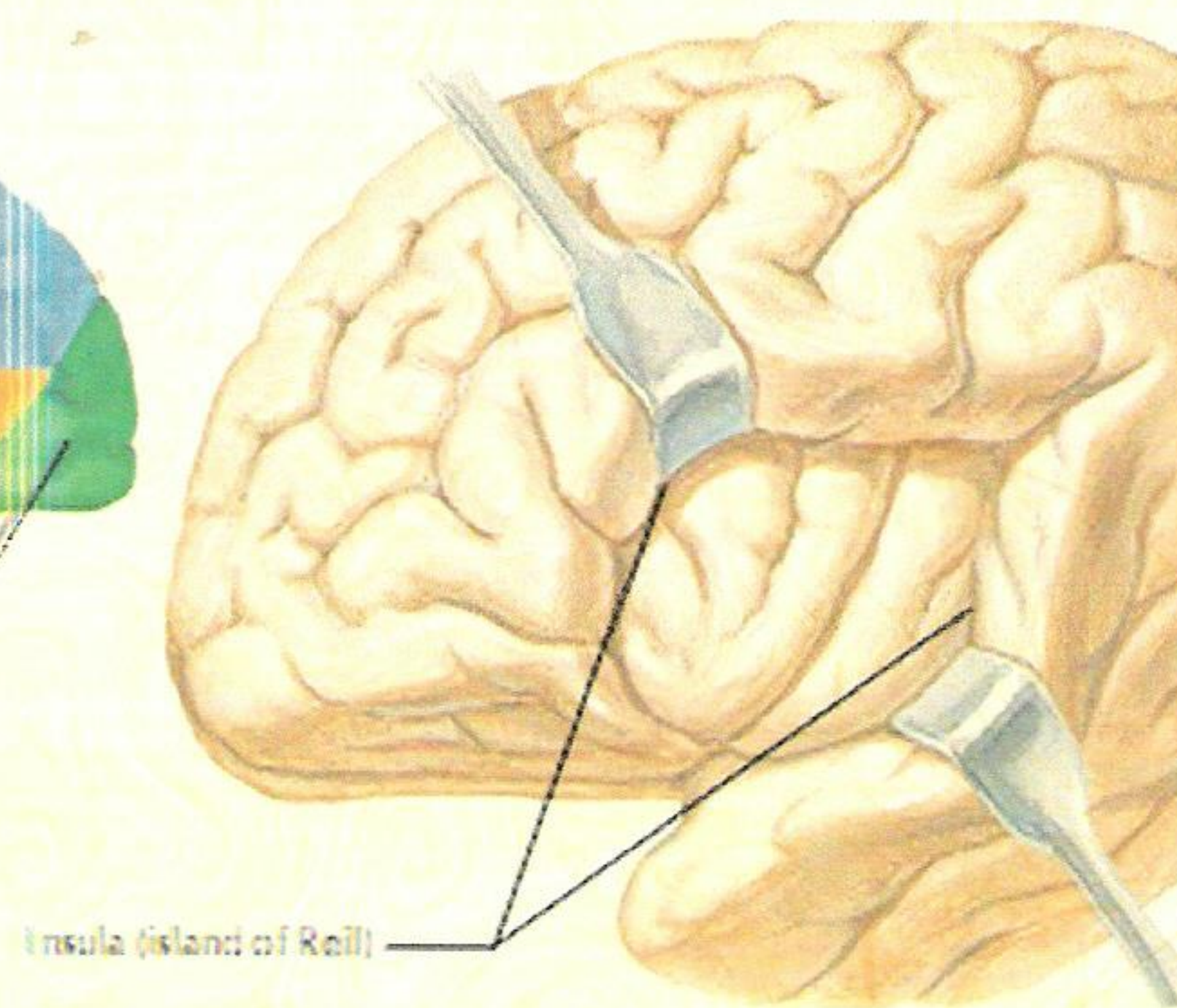
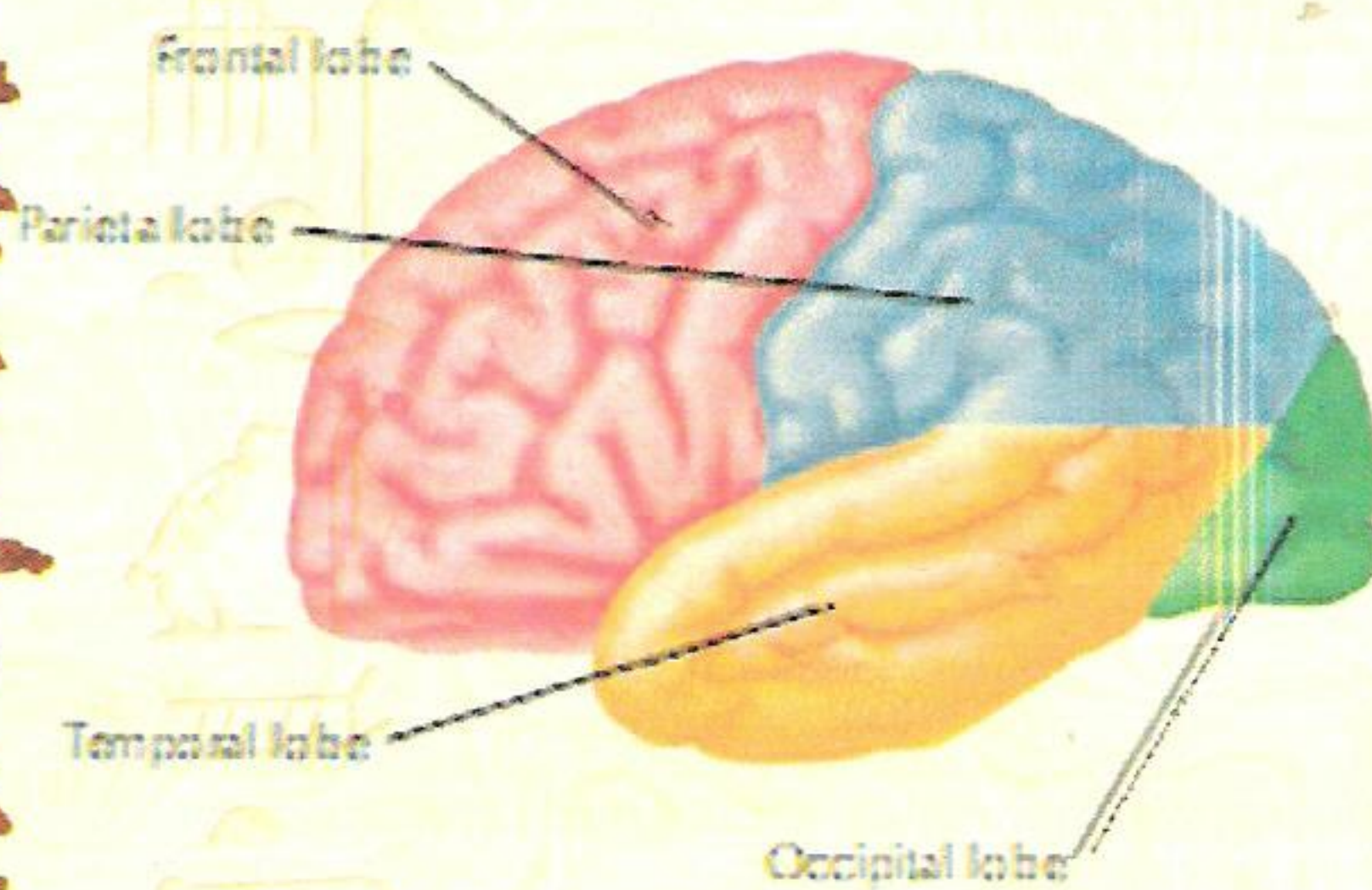




NEUROANATOMY



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2010-2011



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NEURO. ANATOMY 2007

==*== The nervous system is divided according to :

- [A] Position (anatomy) into
- ① Central nervous system → Brain
→ spinal cord
 - ② Peripheral nervous system → cranial nerves.
→ spinal nerves
- [B] Function (physiology) into
- ① Somatic N/s → motor.
→ sensory.
 - ② Autonomic N/s → sympathetic
→ parasymp.

==*== The CNS is covered by 3 meninges (dura mater, arachnoid & pia mater) from outside into inside covering the brain & spinal cord

The Meningeal spaces are:

- ① Extradural (epidural) space:- between dura & periosteum of bones.
- Contains loose C.T. & internal venous plexus.
- ② Subdural space:- between dura & arachnoid mater.
- contains thin film of fluid.
- ③ Subarachnoid space:- between arachnoid & pia mater.
- Contains cerebrospinal fluid (CSF) & spinal nerve roots.

==*== The brain is divided according to :-

[A] Morphology into: ① Cerebrum (+ thalamus & hypothalamus).

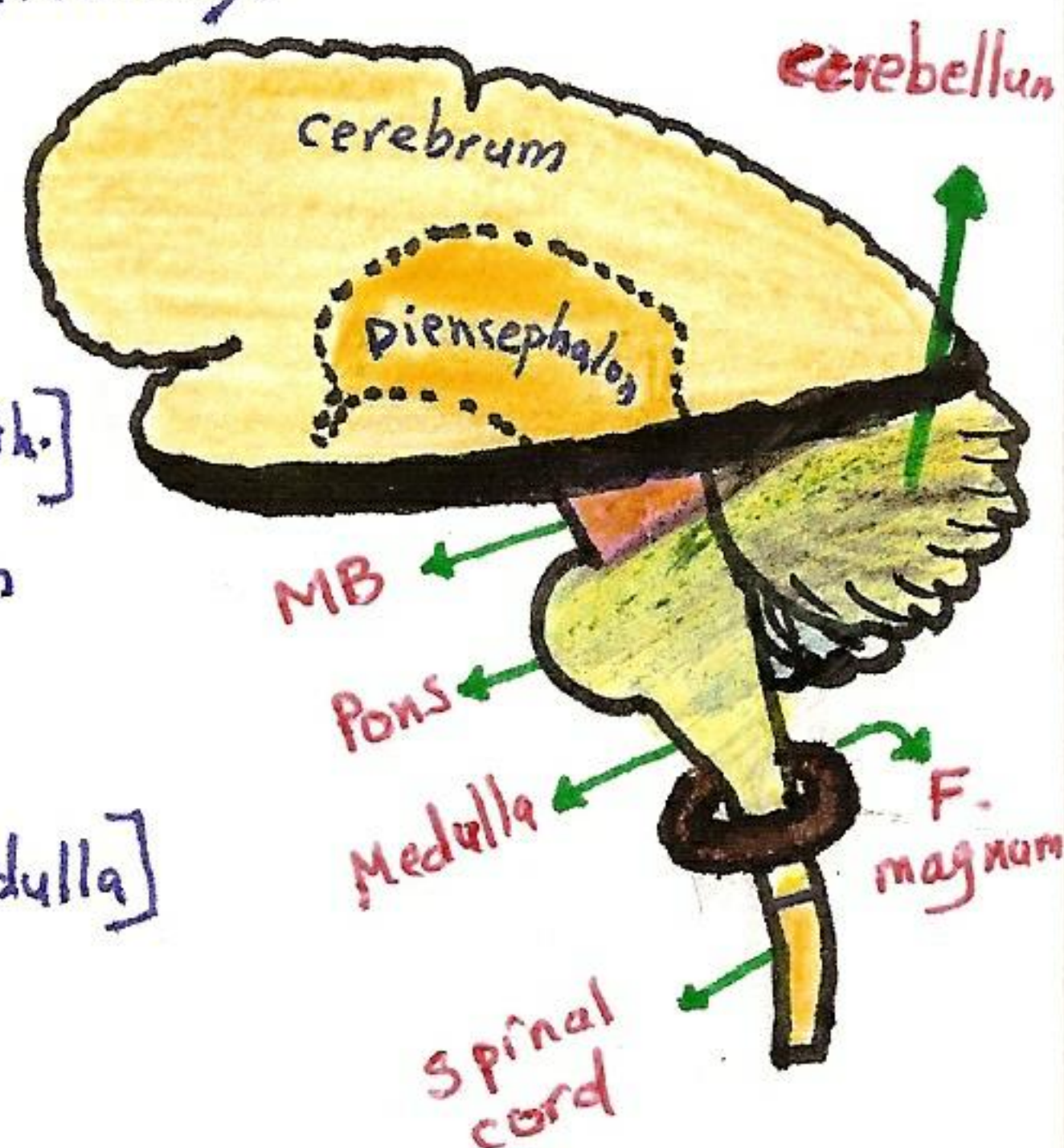
② Cerebellum.

③ Brain stem → Midbrain.
→ Pons.
→ Medulla.

[B] Embrology into:- ① Forbrain [cerebrum + thalamus & hypoth.]
→ telencephalon Diencephalon

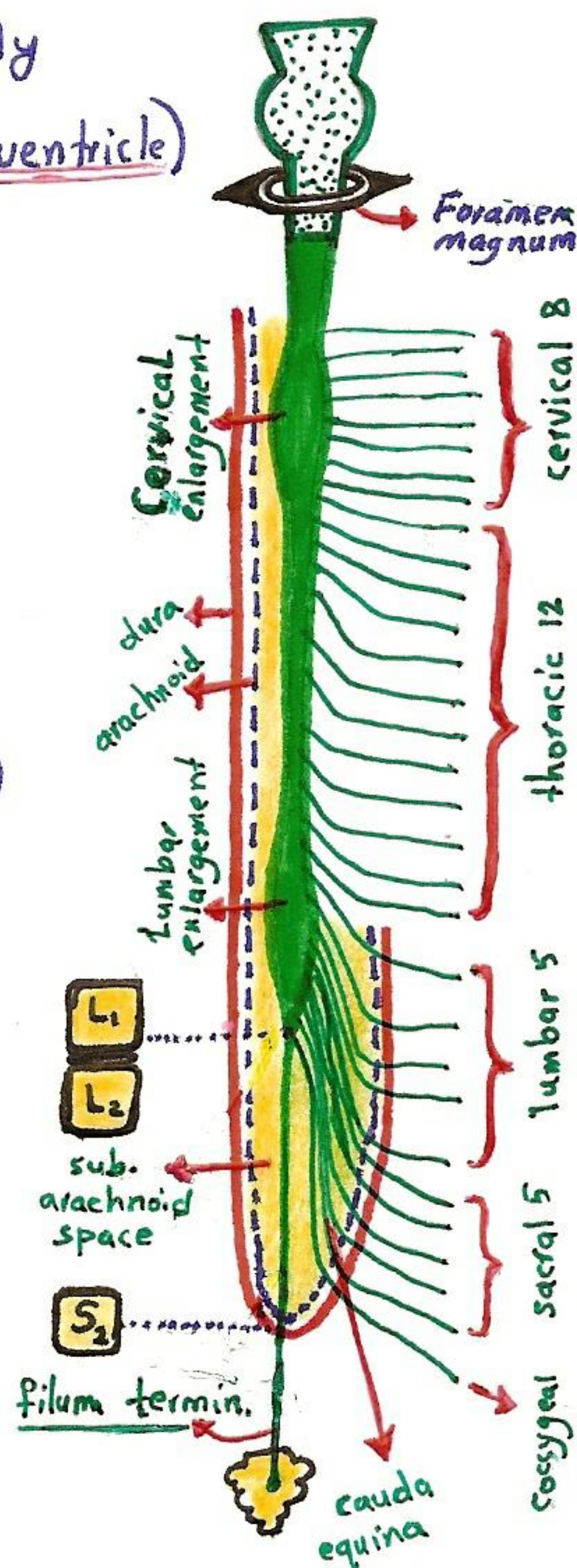
② Midbrain.

③ Hindbrain [cerebellum + Pons + medulla]



SPINAL CORD

- The spinal cord starts just below foramen magnum as a continuation of the medulla oblongata & ends in the adult at the lower border of L₁. , it is about 45 cm.
- At birth ends at L₃ level while at the 3rd month of fetal life it ends at end of vertebral canal (ie fills the canal).
- The lower end of spinal cord is tapered conically forming conus medullaris (cavity inside called terminal ventricle)
- The spinal cord shows two enlargement
 - ① Lumbar enlargement (site of lumbar & sacral plexuses).
 - ② Cervical enlargement (site of brachial plexus).
- The pia mater adherent to spinal cord & ends at same level (L₁) where it extends downwards as the filum terminale (attach to coccyx - second piece-)
- The arachnoid & dura mater end opposite (S₂)
- The spinal nerves in the upper part are horizontal and in the middle are oblique while in the lower part of spinal cord arise vertically forming cauda equina.



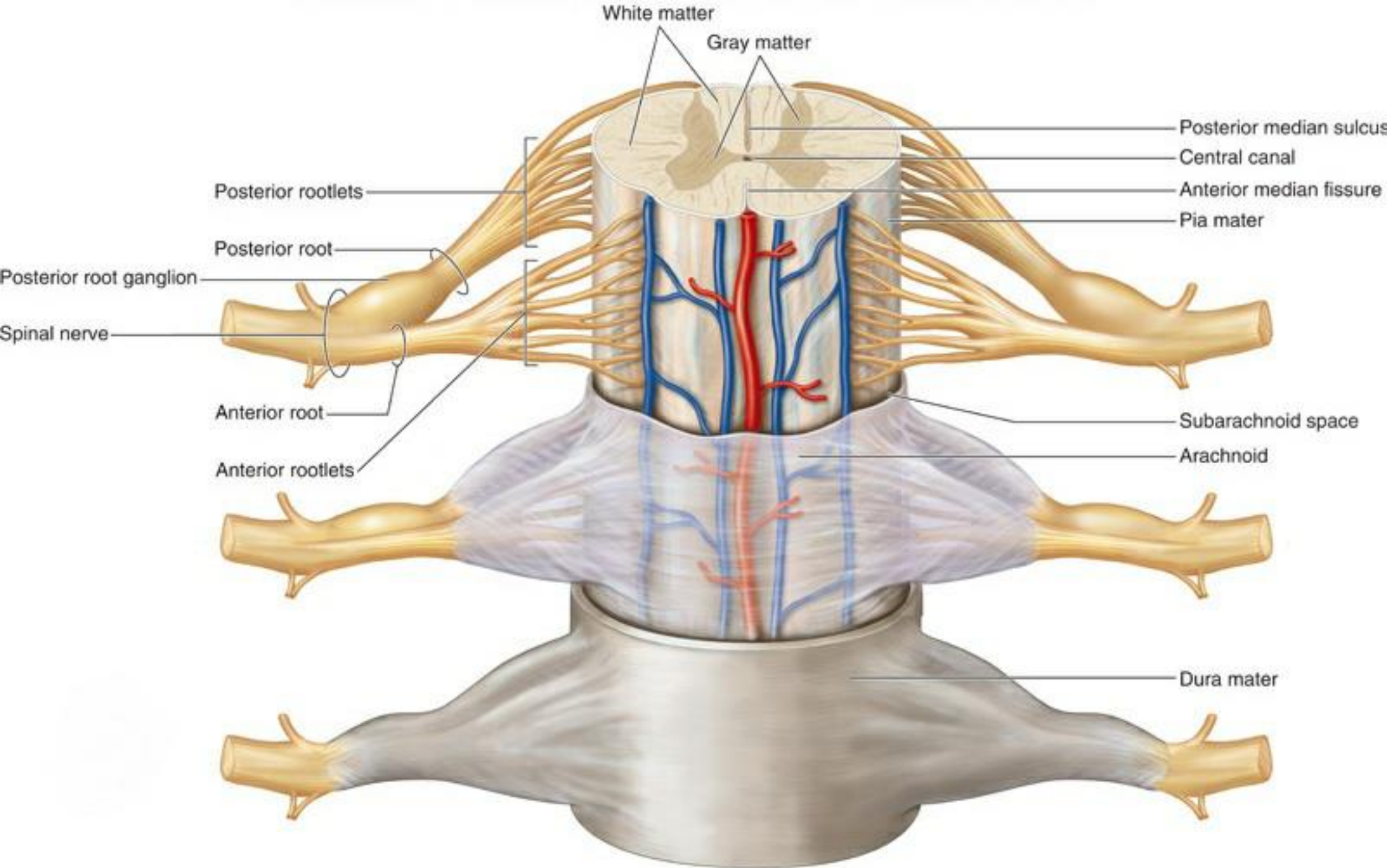
* Structures fixing spinal cord:

- ① filum terminal.
- ② Denticulate ligaments (thickening of pia mater on both sides attach to dura)
- ③ Dura mater attached to foramen magnum & vertebral foramina.

* Spinal nerves:- arise by 2 roots ① dorsal

- ① dorsal root → sensory fibers & carrying spinal (sensory ganglion).
- ② Ventral root → motor fibers

- The 2 roots unite at intervertebral foramen & divide immediately after emerging from foramen into ant. & posterior 1st rami.

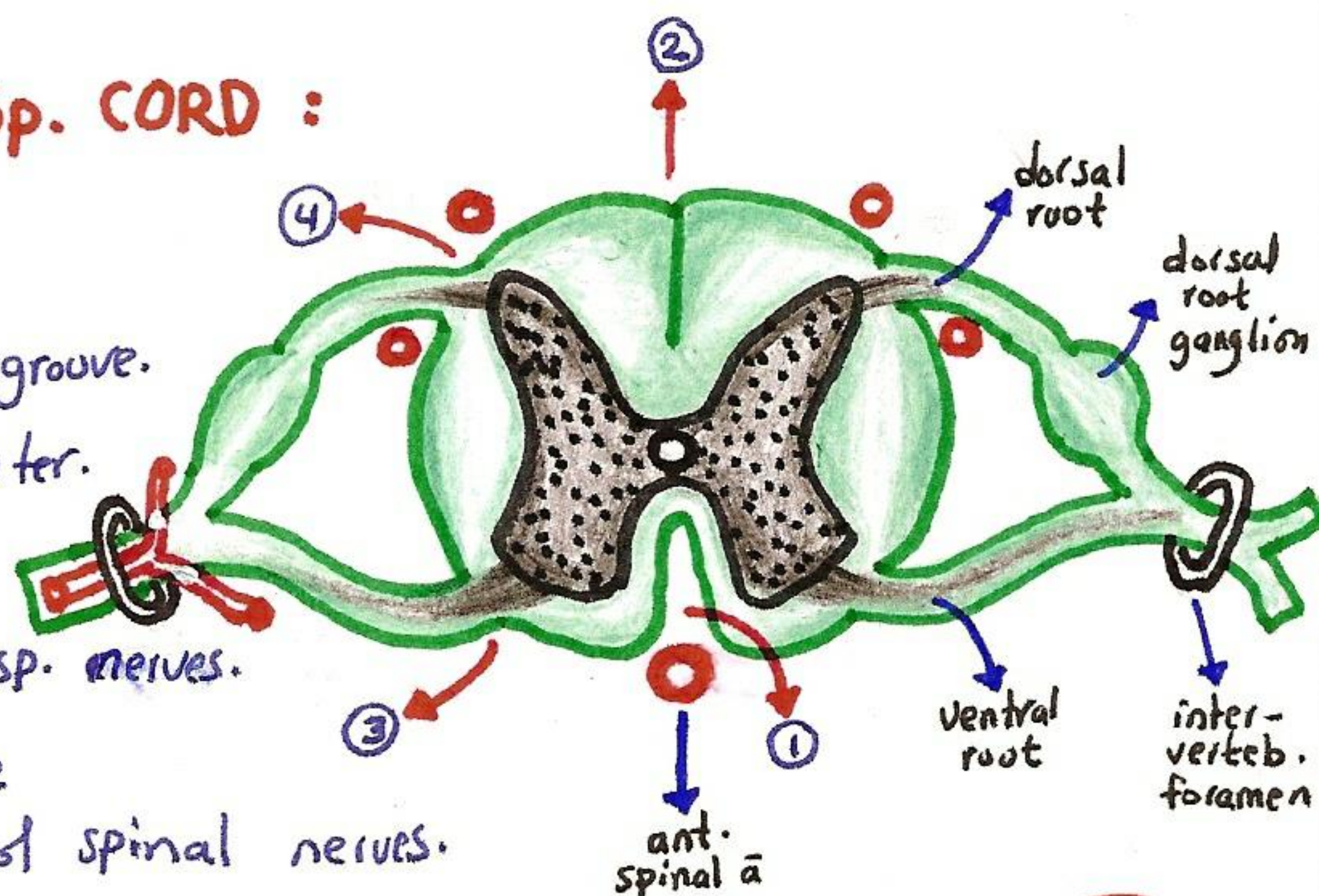


(b) Anterior view

* EXTERNAL FEATURES OF Sp. CORD :

- The spinal cord shows :-

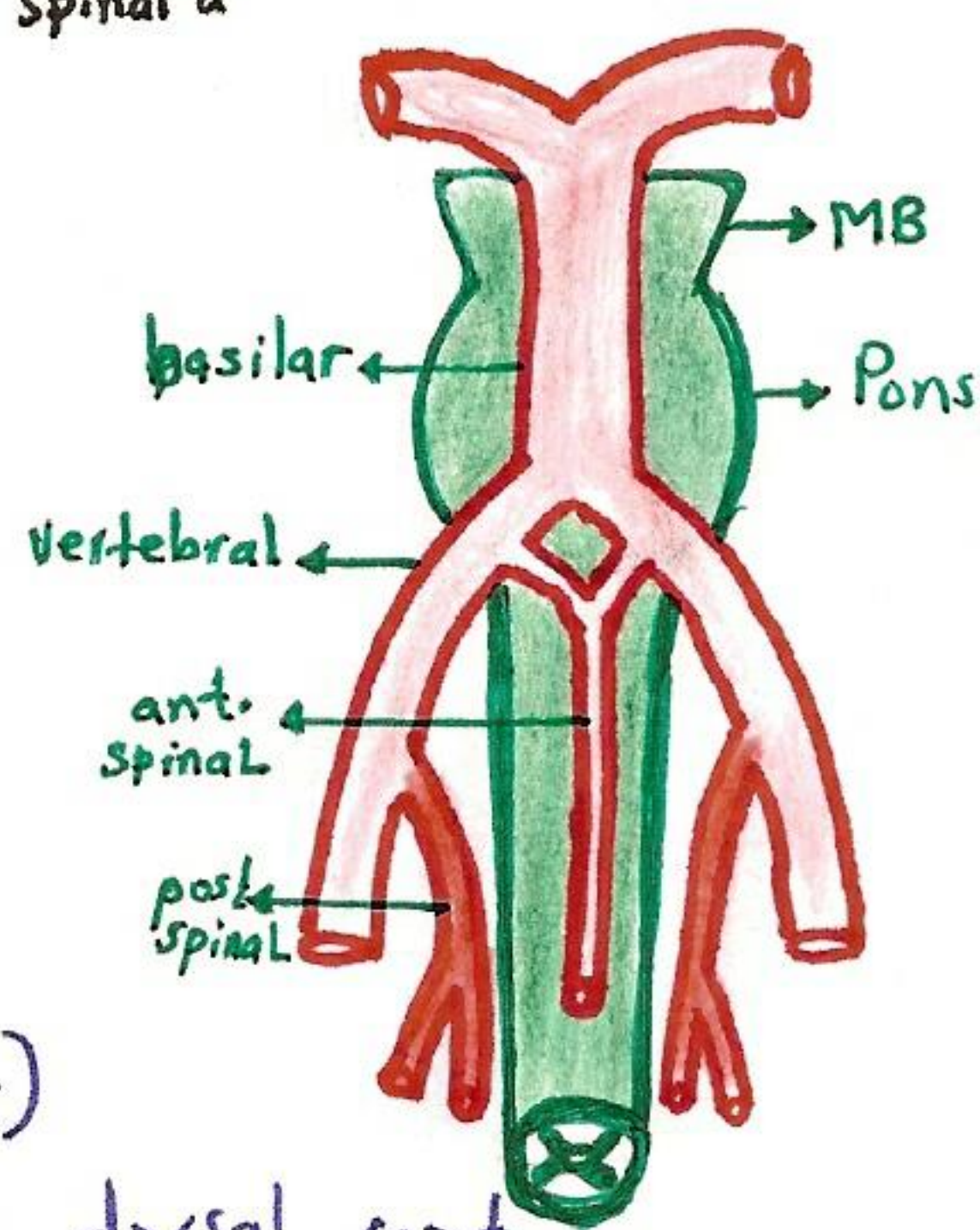
- ① Ant. median fissure (sulcus) : deep groove.
- ② Post. " septum :- from pia mater.
- ③ Two Antero lateral sulci :- at site of emerging of motor root of sp. nerves.
- ④ Two Postero-lateral sulci :- at site of entrance of sensory root of spinal nerves.



* BLOOD SUPPLY OF SP. CORD :

[A] ARTERIAL SUPPLY :

- ① Ant. spinal a (the longest a in the body).
formed by union of Rt & Lt ant. sp. a from Rt & Lt vertebral a. descend in ant. median fissure.
- ② Post. spinal a (Rt & Lt) :- from vertebral a (Rt & Lt)
then each artery divides into 2 branches around dorsal root
- ③ Radicular arteries: enter through intervertebral foramen, arise from:
 - in cervical region: from vertebral a & ascending cervical a.
 - in thoracic " " Post. intercostal & subcostal a.
 - in Lumbar " " Lumbar arteries.
 - in Sacral " " Lateral sacral arteries.



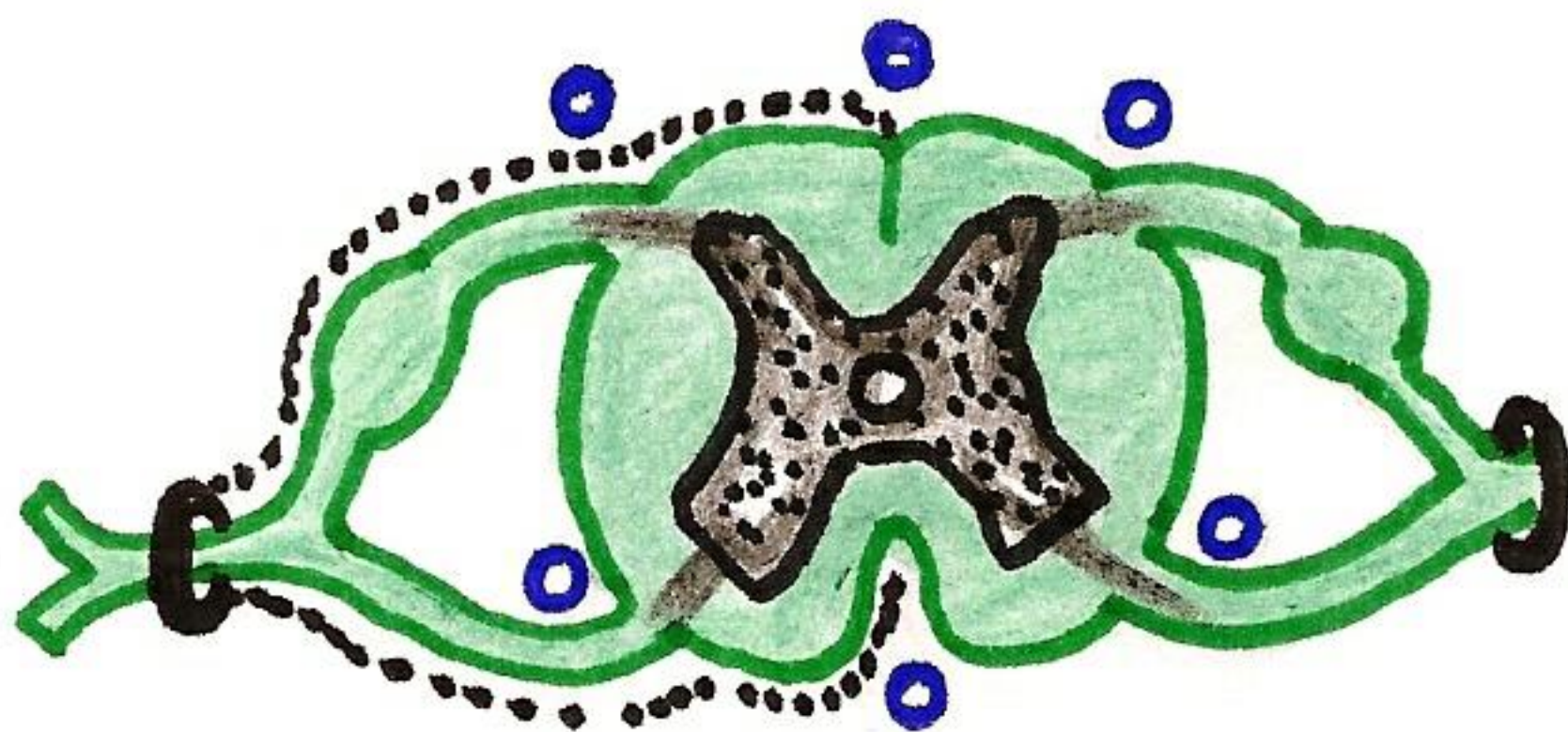
[N.B] the radical a from 2nd lumbar a is the largest & called arteria radicularis magna

[B] VENOUS DRAINAGE : by 6 longitudinal veins into:

- ① above: into veins of medulla & dural sinus.
- ② below:- accompany radical a to drain into corresponding veins via the intervertebral foramina.

* The 6 Longit. veins are :-

- one vein in median plane anteriorly.
- one " " " " posteriorly.
- Two veins one behind each ventral root.
- Two " " " " dorsal " "



* Notes :-

- Pia mater: is a delicate vascular membrane, close to cord.
- Arachnoid mater: is translucent membrane.
- Dura mater: is tough, fibrous membrane
- As spinal nerve roots pass toward intervertebral foramina, they evaginate arachnoid & dura forming meningeal root cover extend until ventral & dorsal root fuse.

* Applied anatomy :-

- Lumbar puncture: CSF may be removed at L₃-L₄ or L₄-L₅ (below level of spinal cord)
- Epidural anaesthesia: Anaesthetics may be introduced into epidural space in surgical procedure.
- Spinal anaesthesia: Anaesthetics into sub~~arachnoid~~^{arachnoid} space.

* Internal structure of spinal cord :-

- ① Central canal: small canal continues above with ^{cerebral} ventricular system
 - ② Grey matter: around central canal, consist of nerve cell bodies
 - ③ White matter: consists of ascending & descending nerve fibers.
 - ④ Dorsal horn: contains substantia gelatinosa (transmit nociceptive impulse)
 - ⑤ Ventral horn: contains alpha & gamma motor neurons (lower motor neuron)
 - ⑥ Lateral horn: contains preganglionic sympathetic neurons
- (NB:- Dorsal, ventral & lateral horns are parts of grey matter)

NB:- occlusion of ant. spinal artery leads to:-

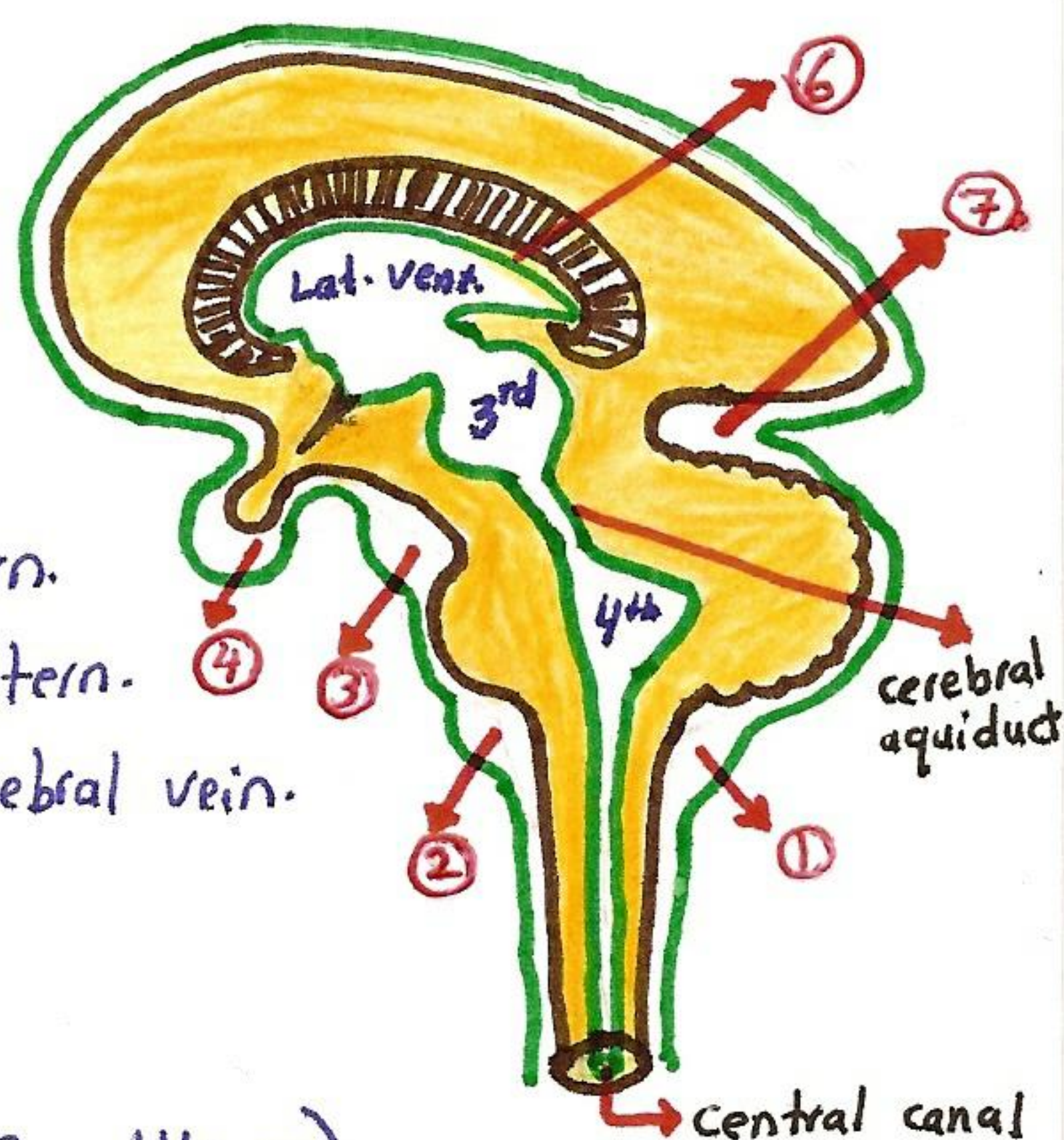
- ① acute thoracic cord syndrome → paraplegia & incontinence.
- ② Spinothalamic modalities of pain & temperature are lost (but proprioceptive function of dorsal columns are relatively preserved).

THE BRAIN

- The brain is divided into; cerebrum, cerebellum & brain stem.
- It is covered by meninges (Pia, arachnoid & dura mater) separated by spaces; the most important is subarachnoid space which contains cerebro-spinal fluid (CSF)

- The Subarachnoid space contains some dilatations called cisterna, they are:

- ① Cerebello-medullary cistern (cisterna magna)
- ② Pontine cistern
- ③ Interpeduncular cistern.
- ④ Chiasmatic cistern
- ⑤ Lateral sulcus cistern.
- ⑥ Cistern of corpus callosum
- ⑦ Cistern of great cerebral vein.

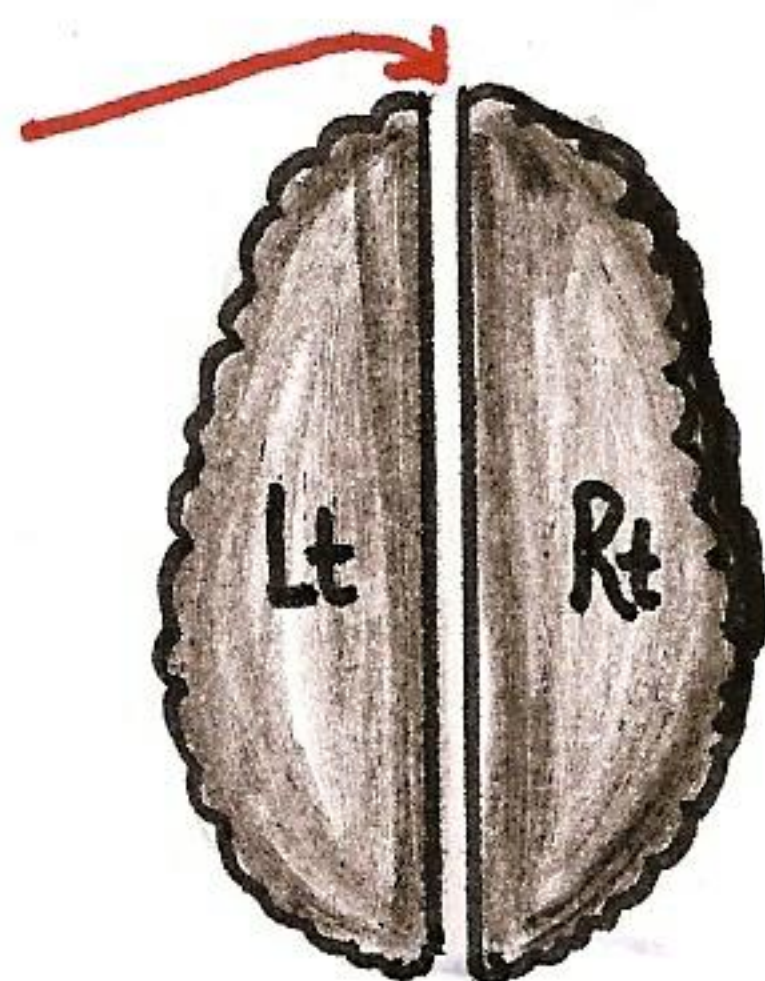


* CSF CIRCULATION :

- The CSF is a clear watery fluid (about 130-140 cc).
- It is produced by choroid plexus (at rate of ≈ 500 cc Per day) in the wall of ventricles (spaces inside CNS).
- The CSF runs from ² Lat. ventricles (space inside cerebral hemisphere) $\rightarrow$ into 3rd ventricle (space inside diencephalon) through interventricular foramen
- from 3rd ventricle $\rightarrow$ into 4th ventricle (space inside hind brain) through cerebral aqueduct (duct inside midbrain)
- from 4th ventricle by 3 foramina (2 Lat. $\rightarrow$ F. of Luschka & 1 median $\rightarrow$ of Magendie) in the roof of 4th ventricle into subarachnoid space $\rightarrow$ where it flows over brain & spinal cord $\rightarrow$ into dural sinuses (mainly SSS) by arachnoid villi & granulation.
- small amount of CSF enters from 4th ventricle into central canal of spinal cord up to terminal ventricle (inside conus medullaris).
- N.B. the pressure of CSF ≈ 100 mm of water.

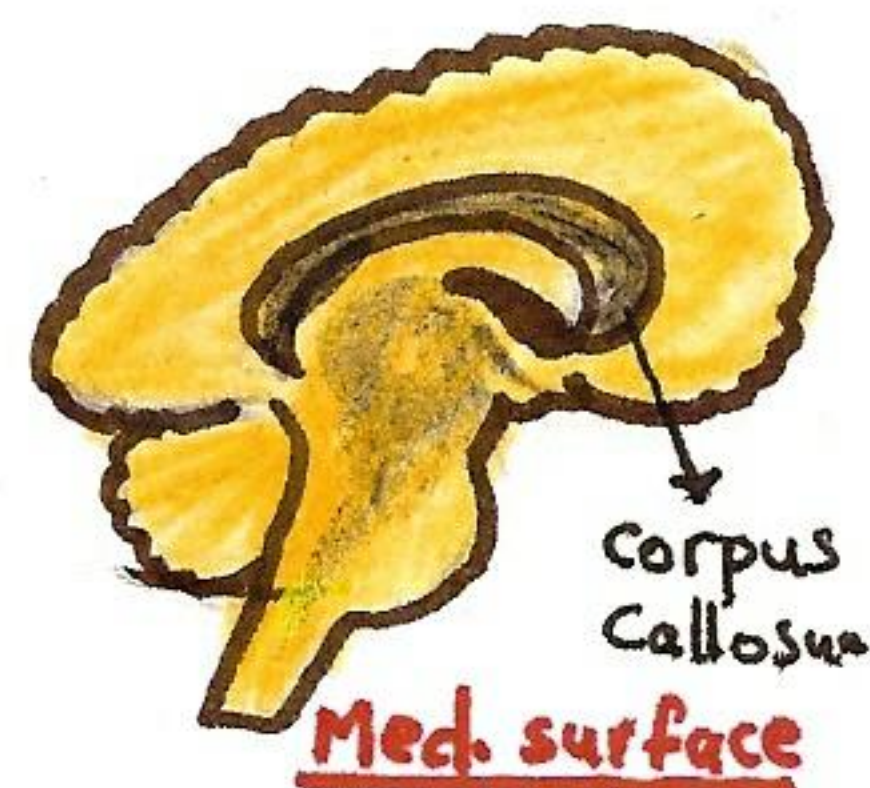
THE CEREBRUM

- The cerebrum is divided incompletely by median longitudinal fissure into 2 cerebral hemispheres united mainly by corpus callosum.



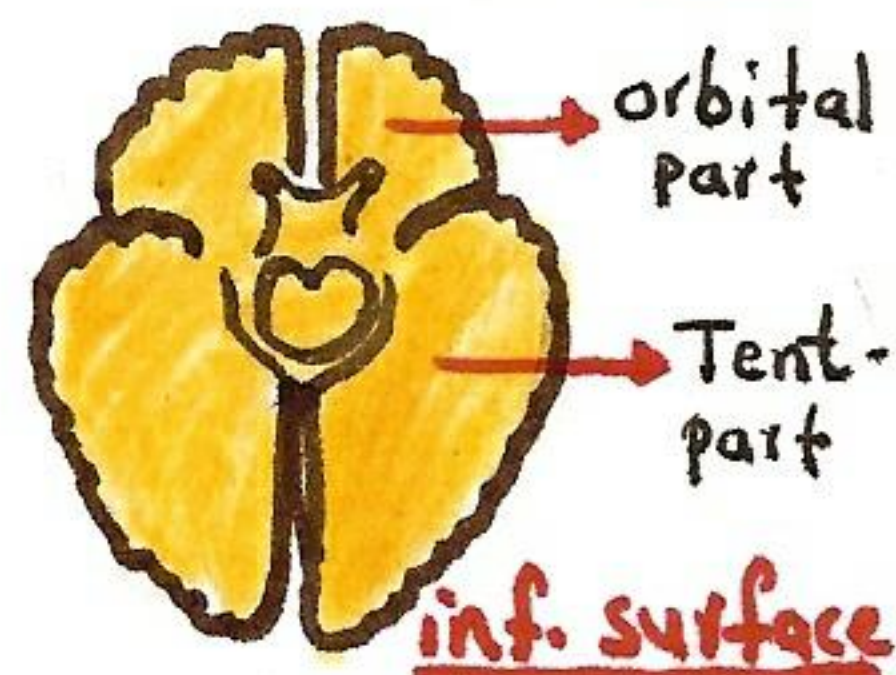
* SURFACES OF cerebral hemisphere: 3 surfaces:

- Medial surface: flat & related to falx cerebri
- Lateral (superiolat): convex " " skull vault.
- Inferior surface: irregular & divided into orbital part (above orbit) & tentorial part (above T. cerebelli)



* BORDERS OF Cerebral hemisphere: 3 borders:-

- Superior (superio-medial) border: from frontal pole to occipital pole → separate medial from lat. surface.
- Inferior (infero-lat): from temporal to occipital pole. and separates lat. from inferior surface.
- Superciliary border: separate lat. from orbital part of inf. surface.



* MAJOR SULCI OF cerebral hemisphere: 3 sulci:-

- Central sulcus (fissure of Rolando): separate frontal (F) from Parietal lobe (P).
- Lateral sulcus: separate temporal lobe (T) below from (F) & (P) above.
- Parieto-occipital: " occipital lobe (O) behind " (P) & (T) in front.

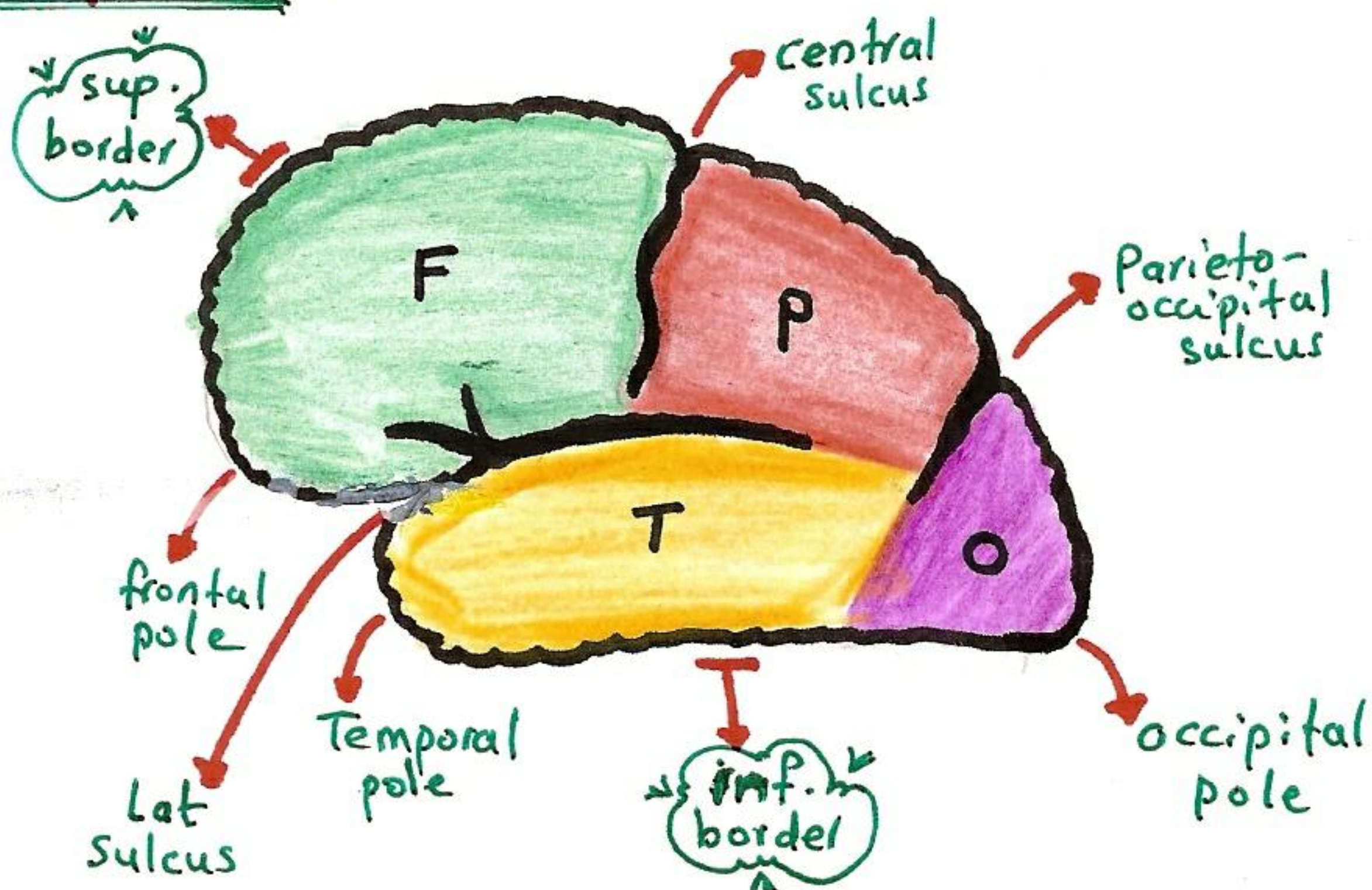
Fissure of Sylvius

* LOBES OF cerebral hemisphere: 4 Lobes.

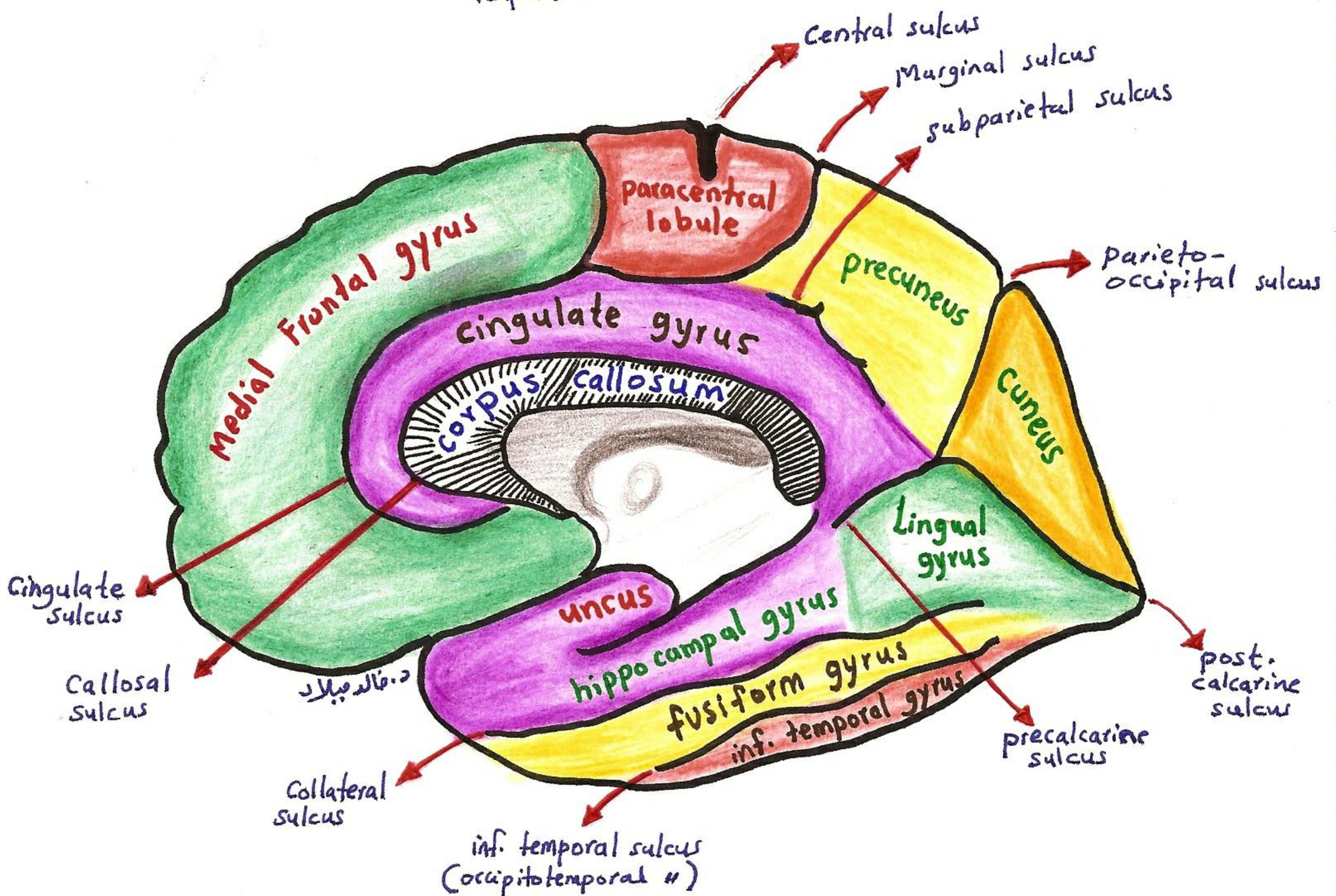
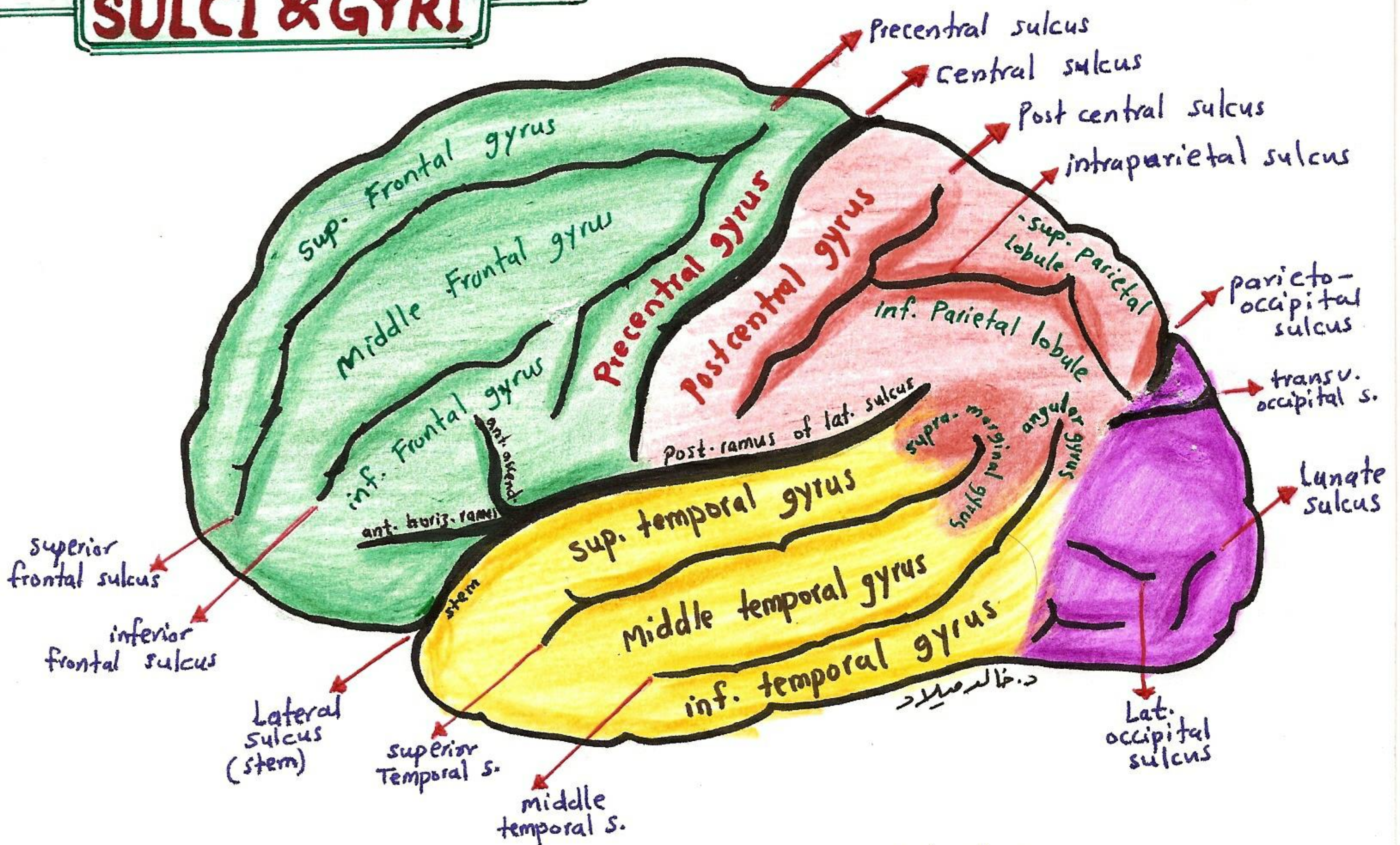
- Frontal lobe (F)
- Parietal lobe (P)
- Occipital lobe (O)
- Temporal lobe (T)

* POLES OF C.H: 3 poles:

- Frontal pole.
- Occipital Pole.
- Temporal Pole.



SULCI & GYRI



*FUNCTIONAL AREAS OF BRAIN

① MOTOR AREA:

- present mainly in precentral gyrus.
- Supplied by $\left\{ \begin{array}{l} \text{ant. cerebral a (upper } 1/4) \\ \text{Middle " " (lower } 3/4) \end{array} \right.$

② SENSORY AREA:

- present mainly in postcentral gyrus.
- Supplied by $\rightarrow$ same as motor area.
- In both areas the body is represented upside down (foot above...)

③ SPEECH AREA:

- present in inf. frontal gyrus (post. part).
- supplied by middle cerebral (MCA)

④ AUDITORY AREA:

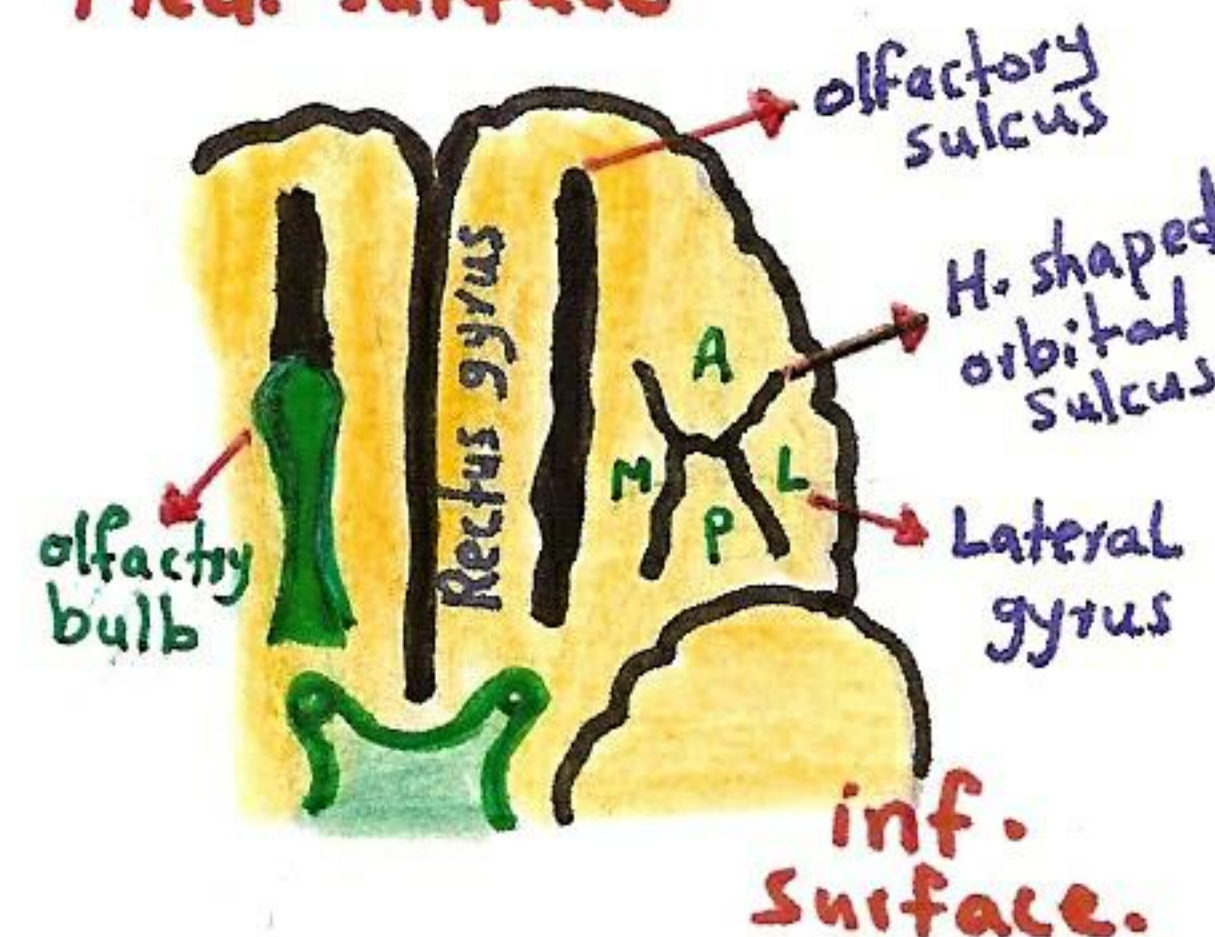
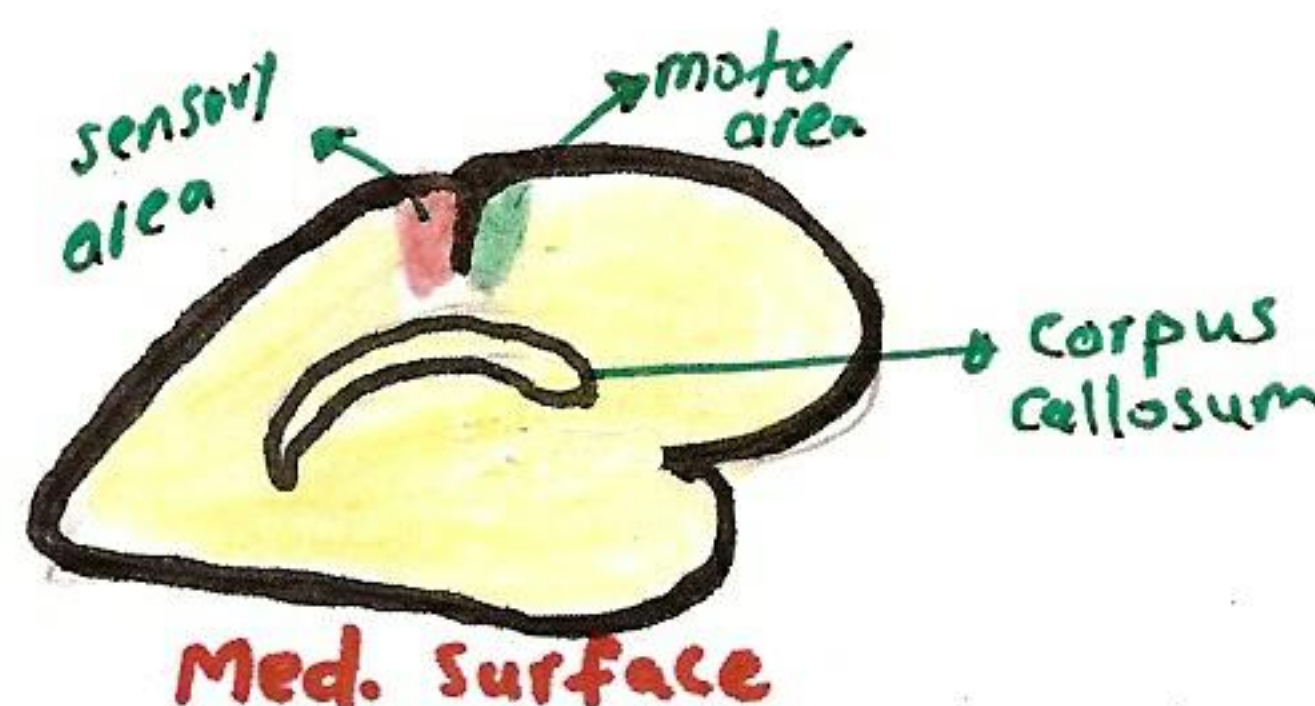
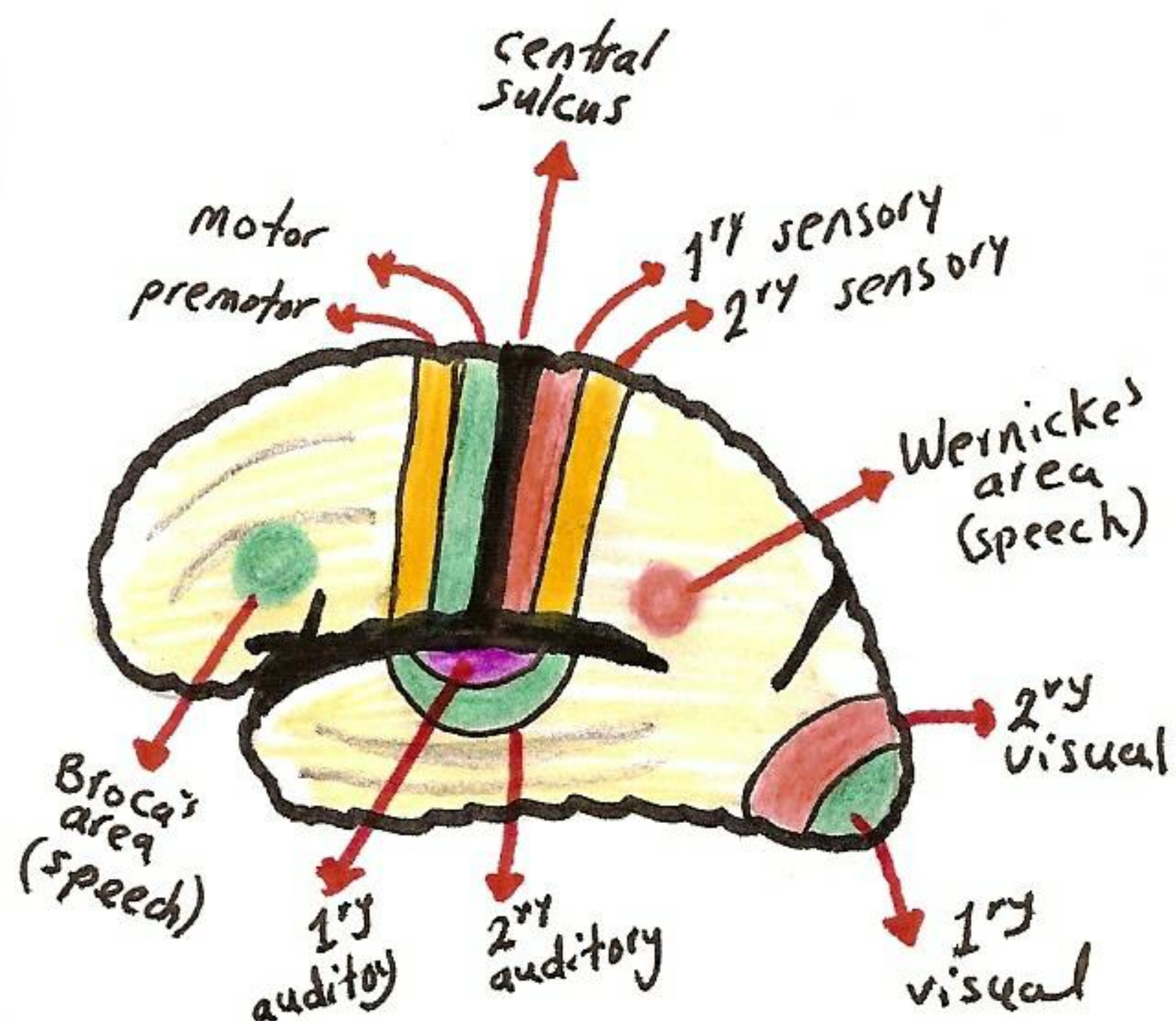
- present in sup. temporal gyrus (middle part)
- supplied by Middle cerebral a (MCA)

⑤ VISUAL AREA:

- present in occipital pole & around post calcarine sulcus.
- supplied by posterior cerebral a (PCA)

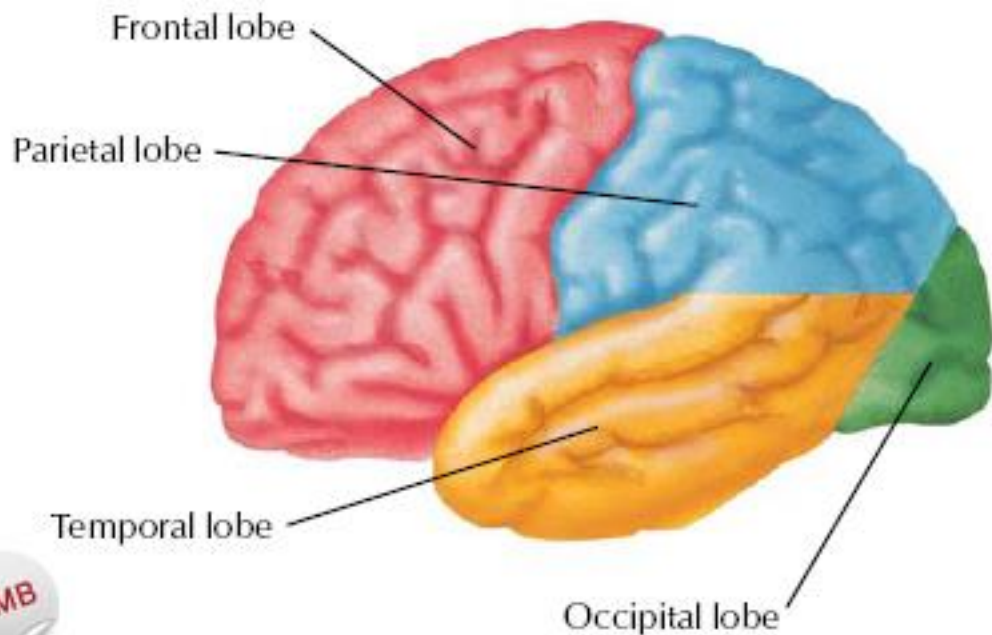
⑥ TASTE AREA:

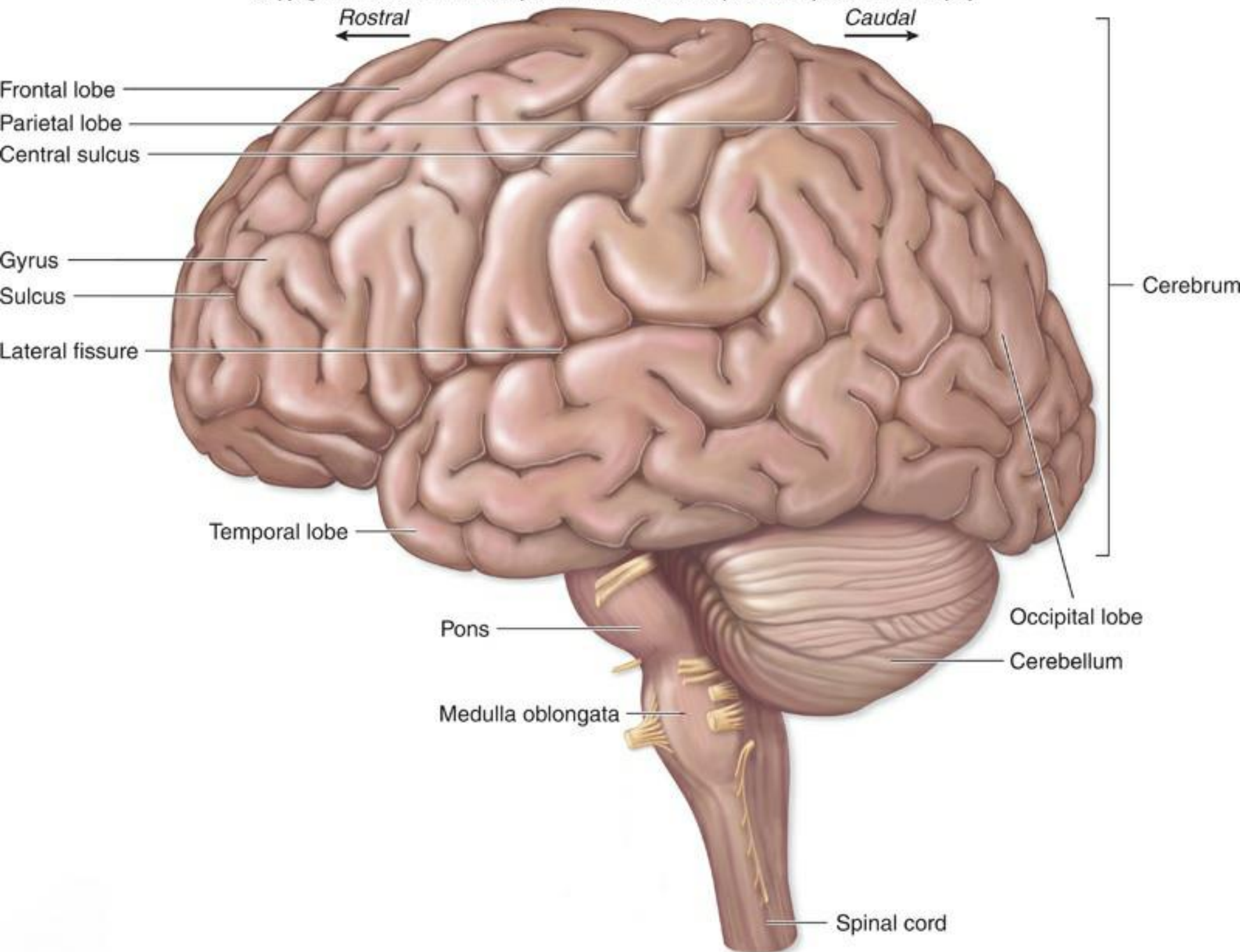
- present in insula in temporal lobe.
- supplied by middle cerebral a (MCA).



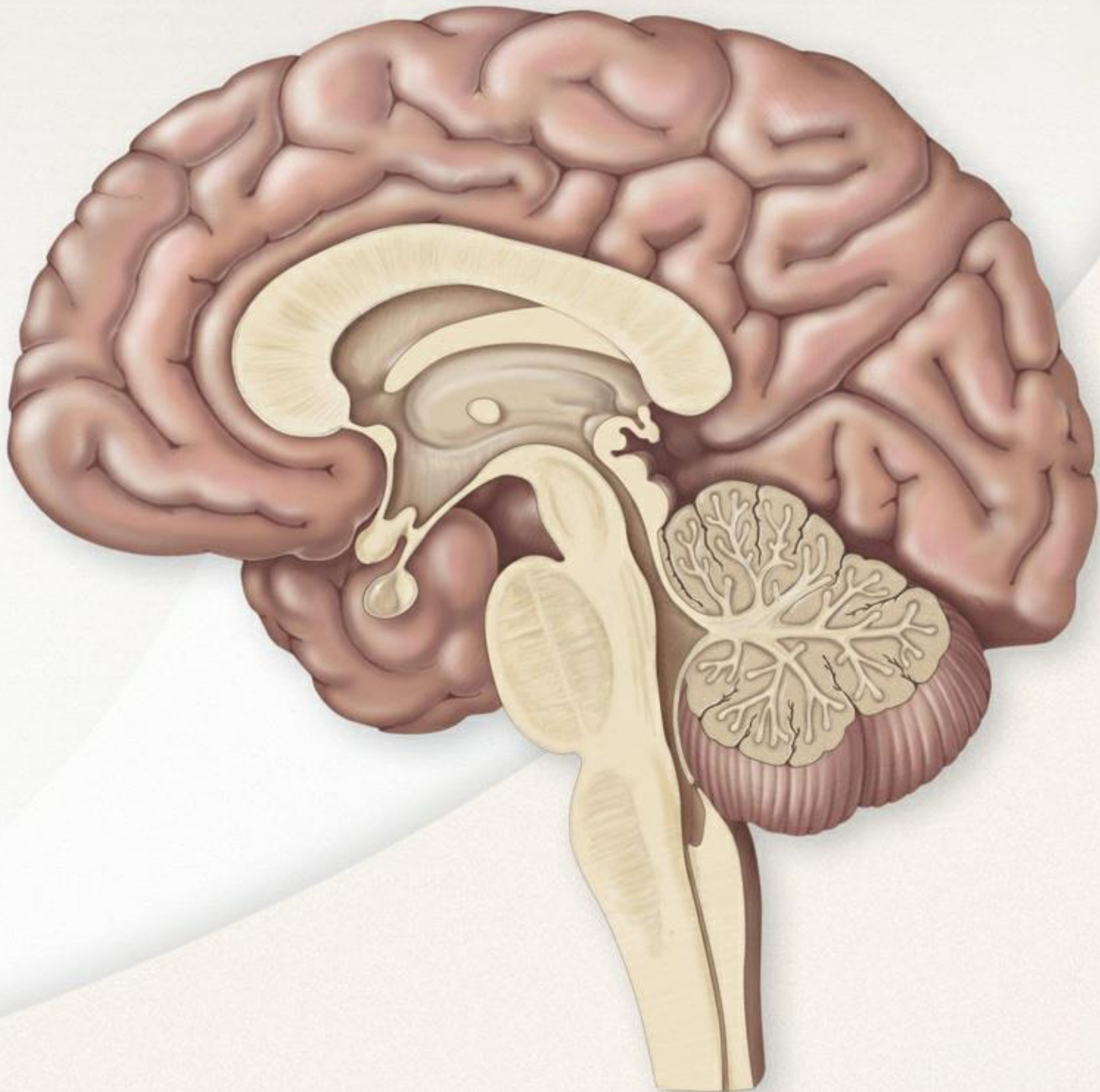
[N.B.] smell area present in the uncus & supplied by PCA

- [N.B.] - The motor area is divided into $\left\{ \begin{array}{l} \text{Motor area (area 4)} \rightarrow 1^{st} \text{ area} \\ \text{Premotor " (" 6)} \rightarrow 2^{nd} \text{ "} \end{array} \right.$
- The Sensory " " " " into $\left\{ \begin{array}{l} 1^{st} \text{ sensory (" 1, 2, 3)} \\ 2^{nd} \text{ sensory (" 5, 7)} \rightarrow \text{association area} \end{array} \right.$
- The Auditory " " " " into $\left\{ \begin{array}{l} 1^{st} \text{ auditory (" 41)} \\ 2^{nd} \text{ auditory (" 42)} \rightarrow \text{association "} \end{array} \right.$
- The Visual " " " " into $\left\{ \begin{array}{l} 1^{st} \text{ visual (" 17)} \\ 2^{nd} \text{ visual (" 18, 19)} \rightarrow \text{association "} \end{array} \right.$
- The Speech area in frontal lobe is motor speech area (Broca's area) (area 44) while in Parietal " is sensory (Wernicke's area - area 22)

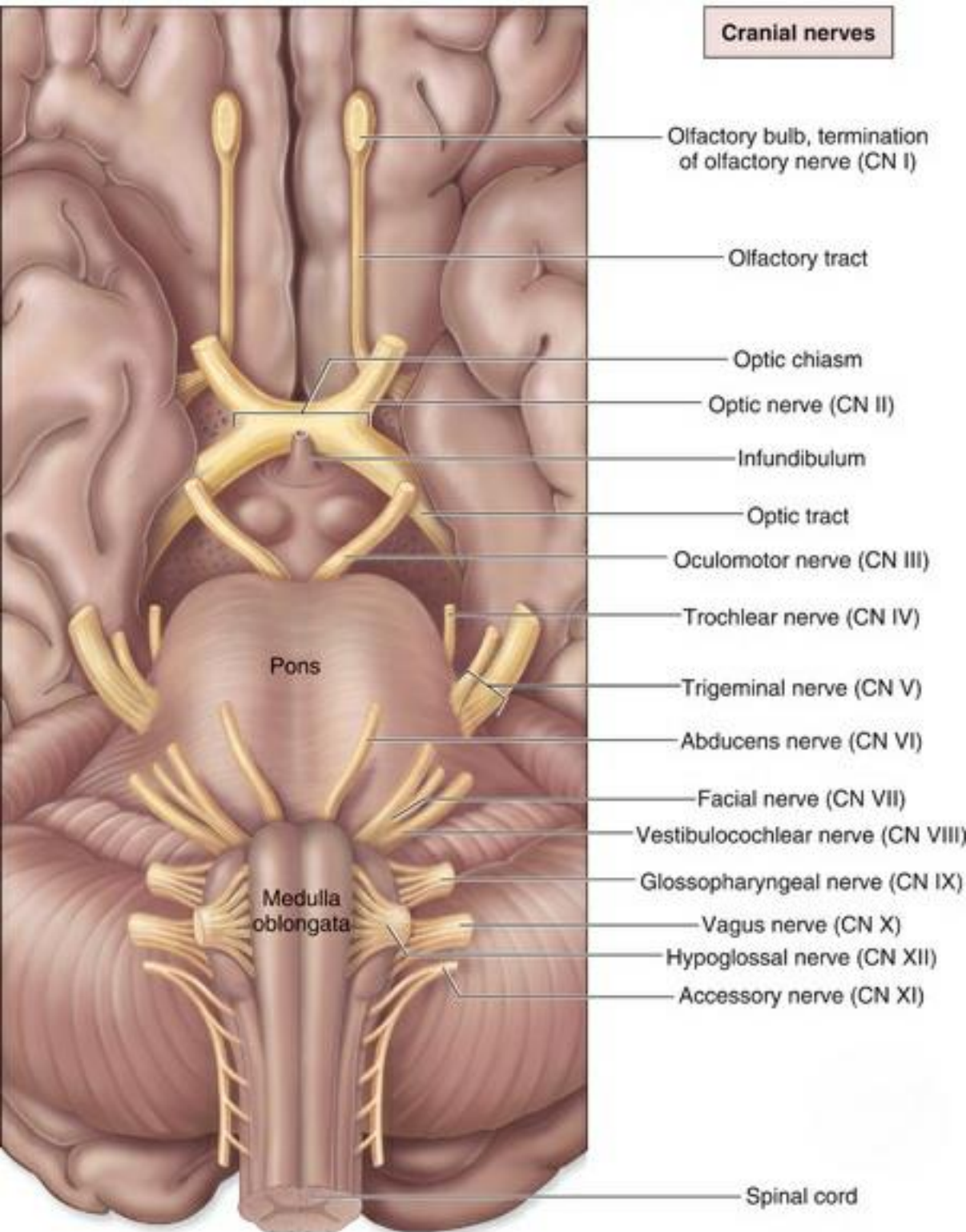




(a) Left lateral view



Cranial nerves



* ARTERIAL SUPPLY OF BRAIN:

- The brain is supplied by vertebral & internal carotid arteries.

(A) VERTEBRAL ARTERY:

- Rt & Lt vertebral arteries are branches of subclavian a (1st part) & enter cranial cavity through foramen magnum.

- The vertebral a ends by uniting with each other (Rt & Lt) to form basilar a [at lower border of pons]

- The basilar artery ends [at upper border of pons] by dividing into two posterior cerebral arteries (terminal branches).

- Both vertebral & basilar a are called "VERTEBRO-BASILAR SYSTEM".

* Branches of vertebral a:

- ① Anterior spinal a
- ② Posterior spinal a
- ③ Medullary branches.
- ④ Post. inf. cerebellar a

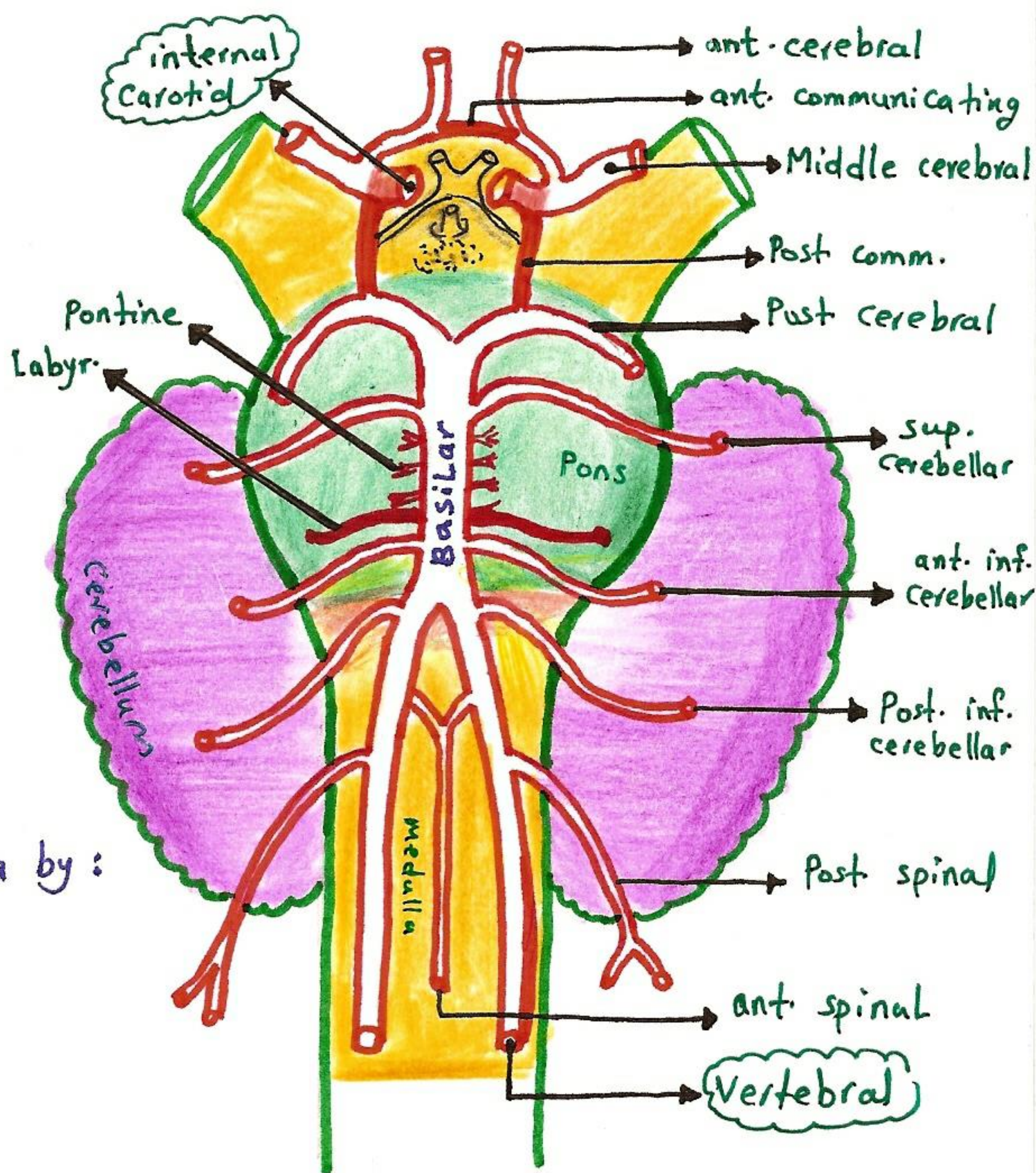
* Branches of basilar a:

- ① Ant. inf. cerebellar a.
- ② Superior cerebellar a.
- ③ Pontine branches.
- ④ Labyrinthine br. (int. auditory a).
- ⑤ Posterior cerebral (terminal).

CIRCLE OF WILLIS

- formed inside interpeduncular fossa by:

- ① ant cerebral (Rt - Lt)
- ② Post. cerebral (Rt - Lt)
- ③ ant. communicating (single)
- ④ Post. communicating (Rt - Lt)
- ⑤ internal carotid a. (Rt - Lt).

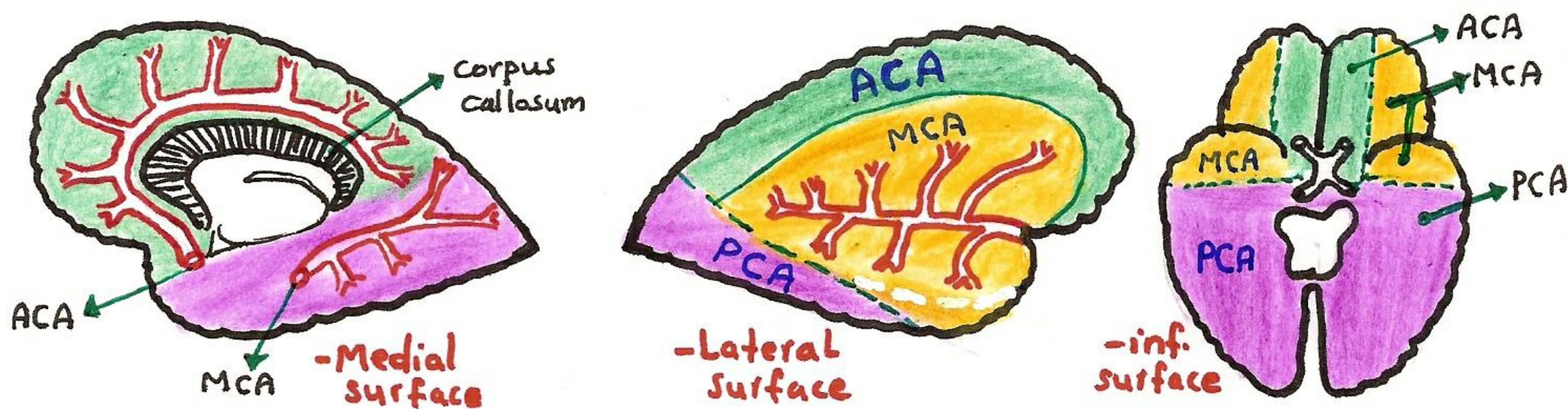


(B) INTERNAL CAROTID A.:

- It is a terminal br. of common carotid a (at C₃-C₄).
- It has 4 parts (cervical-intrapetrous, intracavernous & intracranial).
- The intracranial part gives 5 branches:

- | | | |
|-------------------------|--------------------|-------------|
| ①- Ophthalmic. | ④- ant. cerebral | } terminal. |
| ②- ant. choroid | ⑤- Middle cerebral | |
| ③- Post. communicating. | | |

- Notes: - the ant. cerebral a (ACA) runs mainly in Callosal sulcus.
- the Middle " (MCA) " " " Lateral sulcus.
- the Posterior " (PCA) " " " Calcarine sulcus & parieto occipital "



- The ACA supplies cortex of medial surface of hemisphere (from frontal pole upto parieto occipital sulcus), one inch of Lat. surface (upper part) & medial 1/2 of orbital surface of frontal lobe.
- The MCA supplies cortex of Lateral surface of hemisphere [except 1 inch of superior border by ACA & inferior border by PCA], Lateral 1/2 of orbital surface of frontal lobe & temporal pole and insula.
- The PCA supplies cortex of medial & Lateral surface of occipital lobe also tentorial surface (except temporal pole - MCA) & inferior border.

(11)

*Posterior cerebral artery:-

- Terminal branch of basilar artery.
- Course:- winds around midbrain with optic tract (parallel to superior cerebellar a separated from it by CN III & CN IV)
- Ends beneath splenium of corpus callosum by dividing into
 - ① Parieto occipital artery (in P_o sulcus)
 - ② Calcarine branch (in calcarine sulcus).
- Branches:-
 - ① branches to midbrain.
 - ② Posterior choroidal artery.
 - ③ choroidal plexus of lateral & 3rd ventricles.
 - ④ central branches → thalamoperforating & thalamogeniculate (Pass through Post. Perforating Substance).
 - ⑤ Cortical branches → to occipital lobe, tentorial surface (except temporal pole), inferior temporal gyrus on superolateral surface.

NB:- Central branches supply

- | | |
|-----------------------|----------------------|
| ① Thalamus | ④ Geniculate bodies. |
| ② subthalamic nucleus | ⑤ Mamillary bodies |
| ③ Cerebral peduncle | |

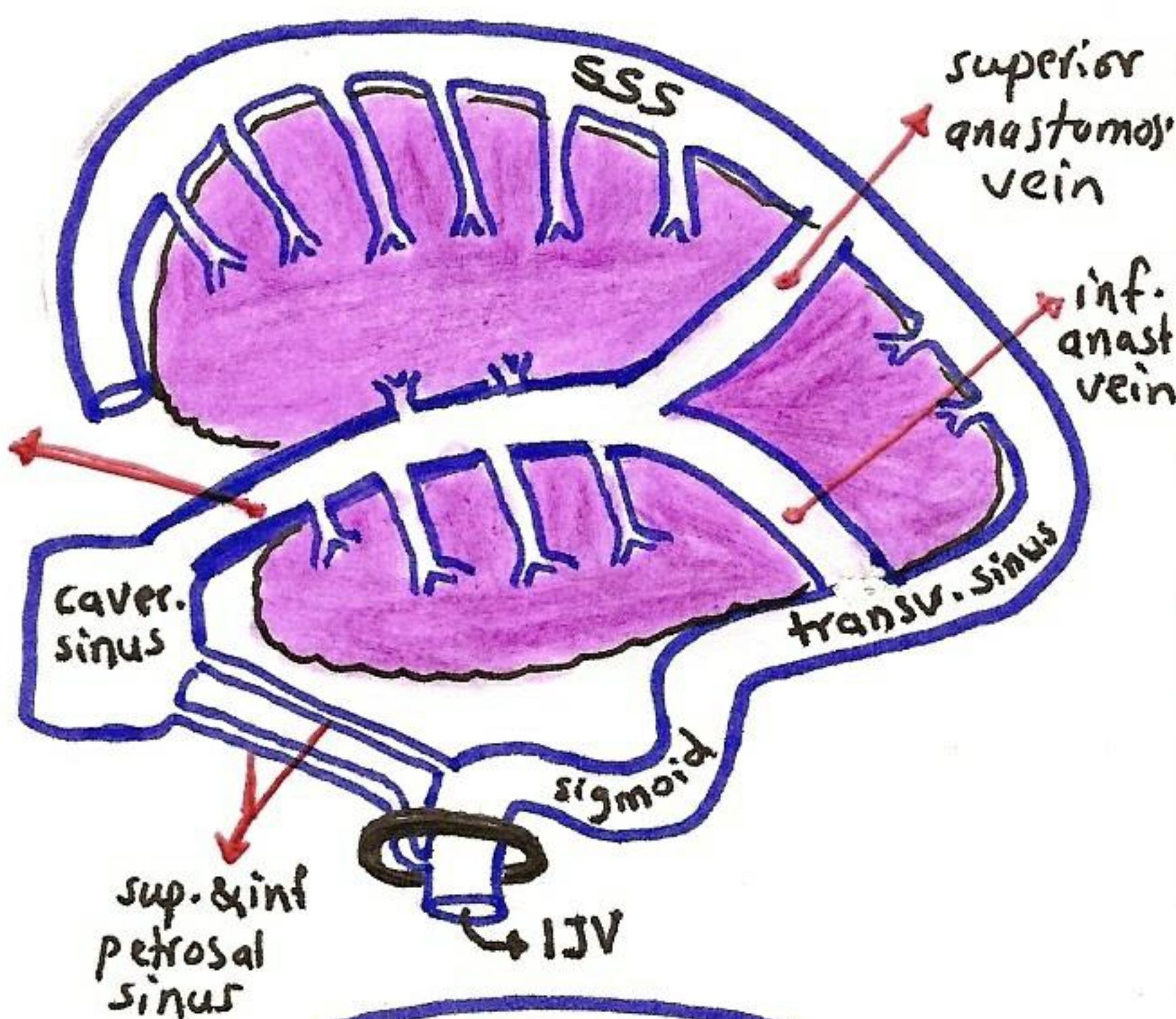
VEINS OF BRAIN :

= They are valveless veins (no valve)

(A) Veins of Lateral surface :

- ① - superior cerebral veins :- 6-12 veins → SSS
- ② - inferior cerebral veins :- drain into → superficial middle cerebral vein ^{MCV} → Cavernous sinus

[N.B] - the superf. mcv connected to SSS & transverse sinus by superior anastomosing & inf. anastomosing veins respectively



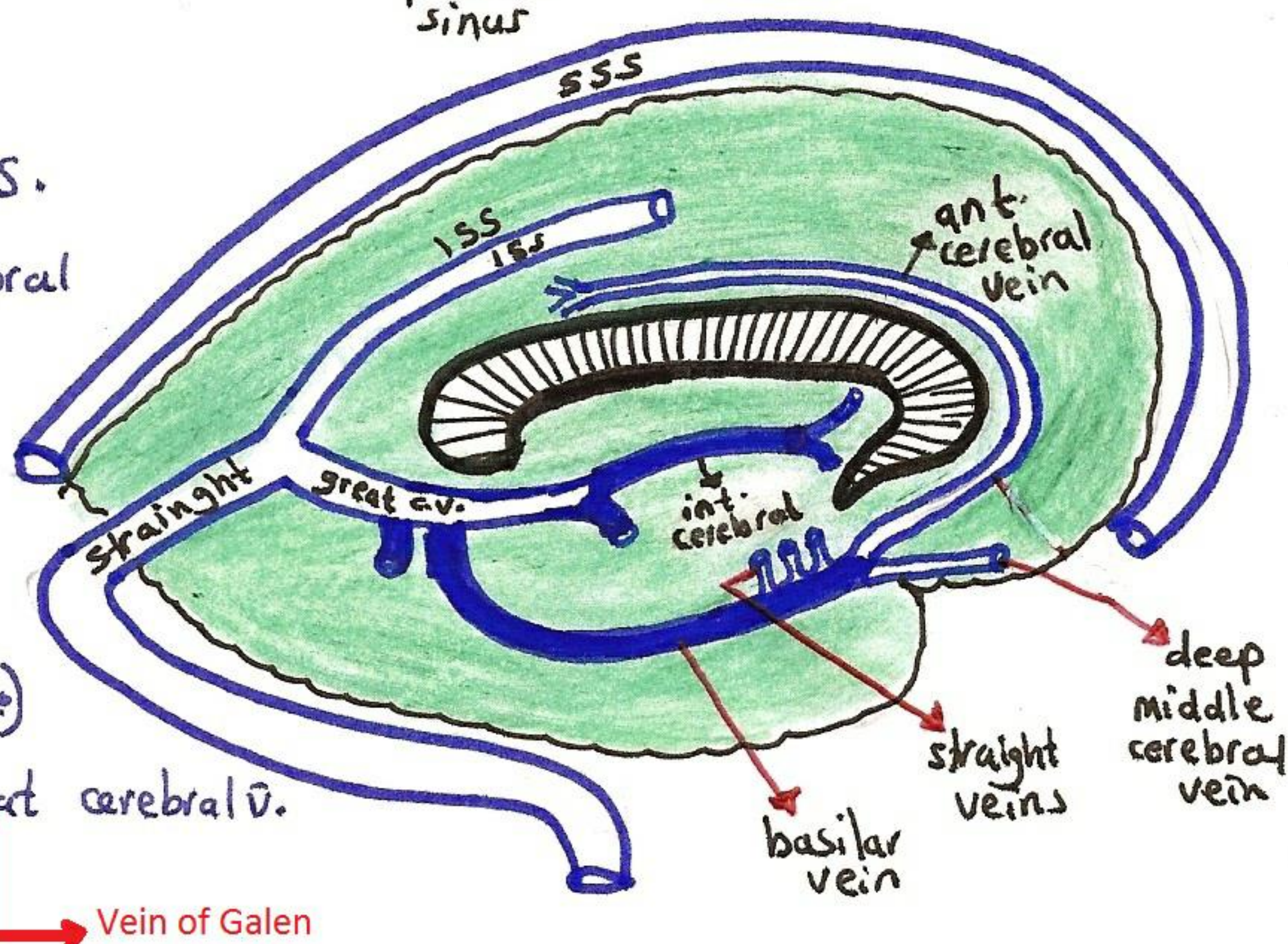
(B) Veins of Medial surface :

= Veins of upper part → SSS & ISS.

= Veins of lower part → ant. cerebral vein (ACV) in callosal sulcus → basal vein which formed by:

- ant. cerebral vein
- deep middle cerebral v.
- Strait veins (through ant perforated substance)

= The Rt & Lt basal vein drains → great cerebral v.



(C) Deep veins of brain :

- = ① - internal cerebral vein (Rt & Lt) : formed beside interventricular foramen by union of (choroid v & thalamostriate vein).
- = ② - Great cerebral vein (single) : formed by union of Rt & Lt internal cerebral veins & receives Rt & Lt basal veins.
- the great cerebral vein ends by uniting with inf. sagittal sinus (ISS) to form straight sinus.

VEINS OF BRAIN :

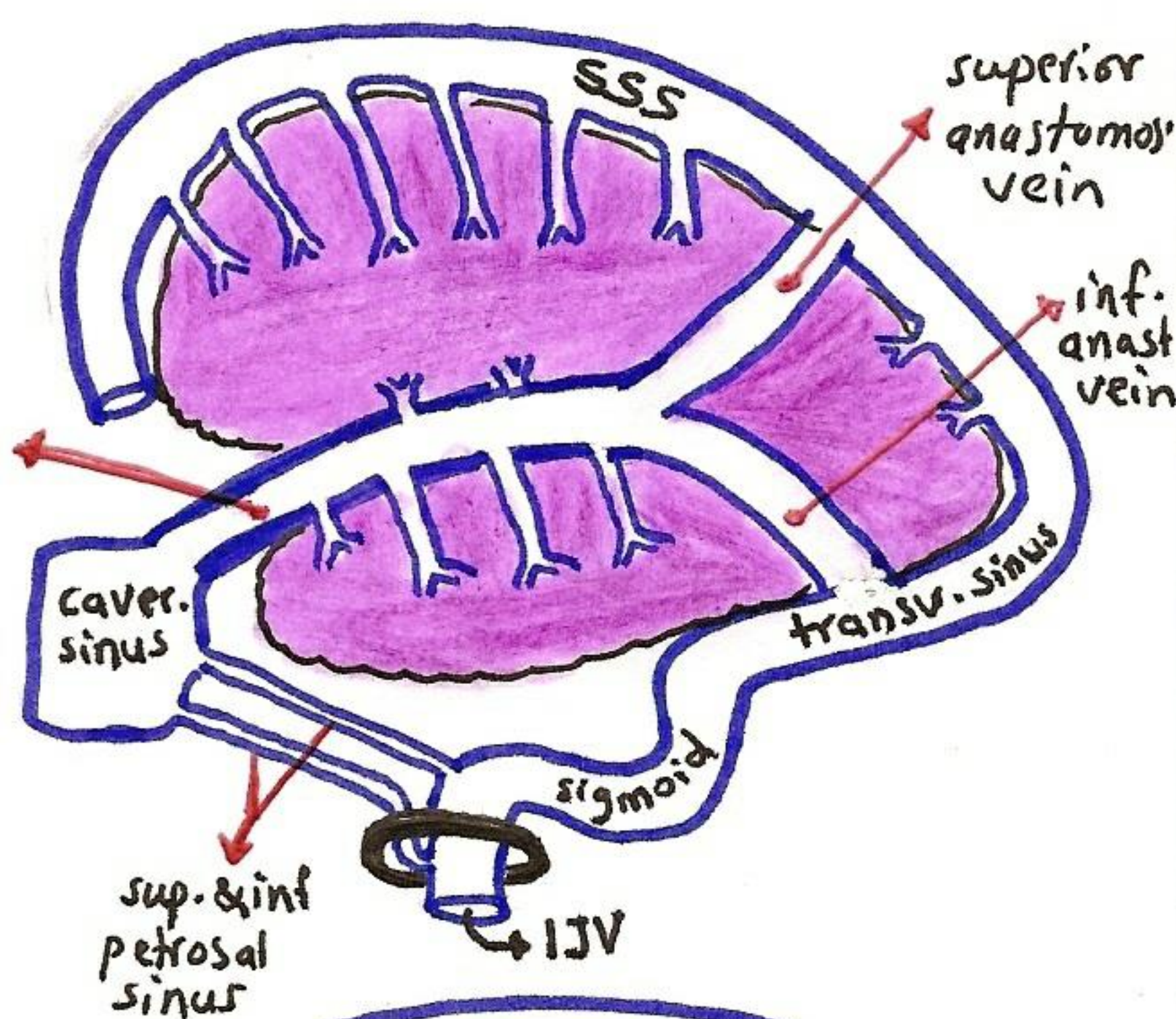
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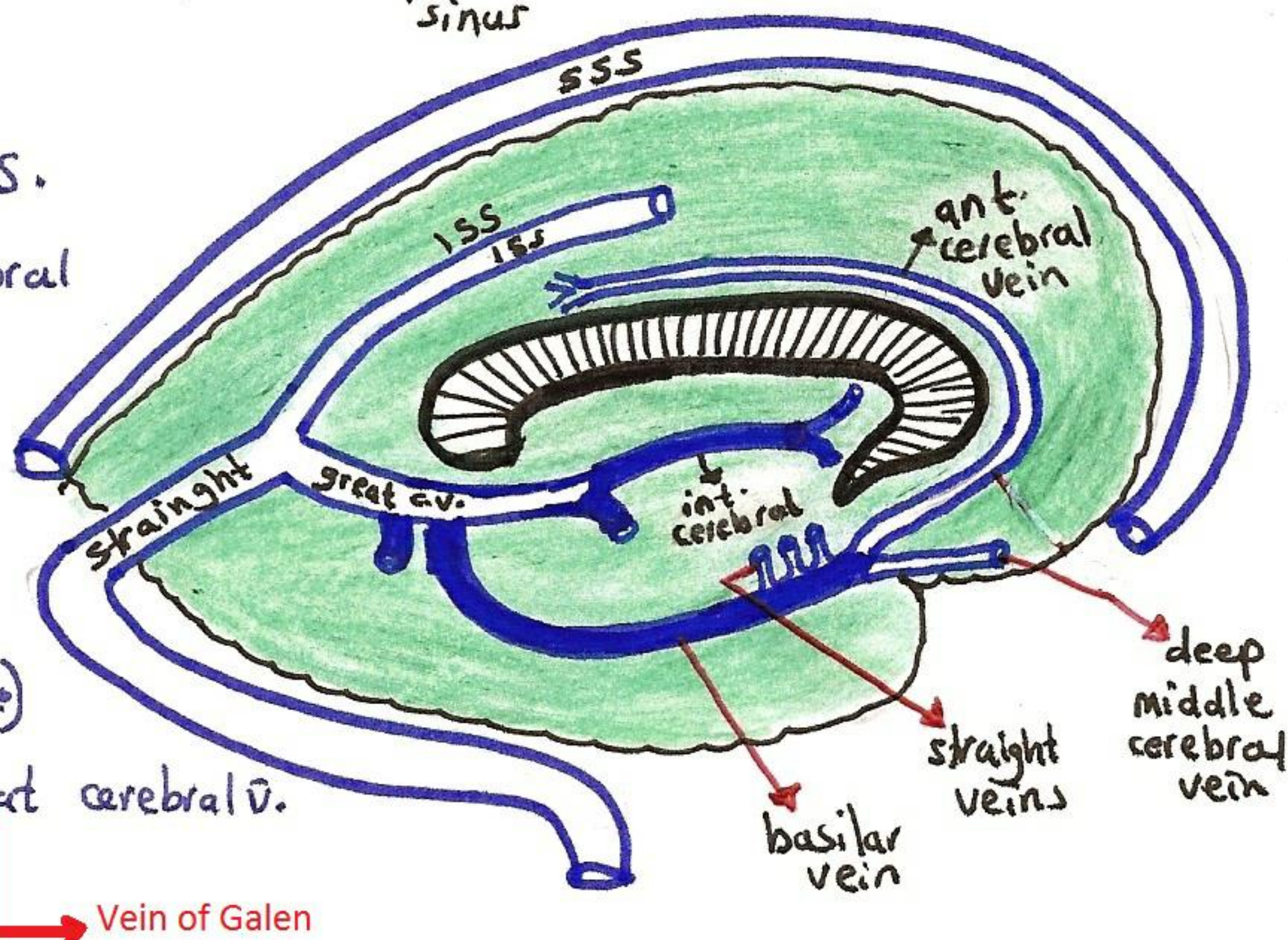
= Veins of lower part → ant. cerebral vein

Vein (ACV) in callosal sulcus →

basal vein which formed by:

- ant. cerebral vein
- deep middle cerebral v.
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= The Rt & Lt basal vein drains → great cerebral v.



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= ① - internal cerebral vein (Rt & Lt) : formed beside interventricular foramen by union of (choroid v & thalamostriate vein) .

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- the great cerebral vein ends by uniting with inf. sagittal sinus (ISS) to form straight sinus.

BRAIN STEM

"External features"

MEDULLA :-

I DORSAL SURFACE :-

A. Closed medulla :-

- It is the caudal $\frac{2}{3}$ of medulla, contains rostral continuation of central canal of spinal cord., external features are :-
- Dorsal median sulcus:- in midline, continuous with that of spinal cord.
- Gracile tubercle:- small elevation containing nucleus gracilis. (NG)
- Cuneate tubercle:- " " " " " " " " " " cuneatus (NC)
- Fasciculus gracilis:- Contains 1st order sensory neurons from sp. cord to (NG)
- Fasciculus cuneatus:- " " " " " " " " " " (NC)

B. Open medulla :-

- related to 4th ventricle floor.
- Floor of 4th ventricle:- is a shallow, rhomboid depression on dorsal surface of rostral medulla ($\frac{1}{3}$) & pons ($\frac{2}{3}$)
- Lateral recess of 4th ventricle:- widest part of 4th ventricle at level of pontomedullary junction to lateral margin of brain stem
- Lateral aperture (foramen of Luschka):- arise from lateral recess from which CSF pass from 4th ventricle to subarachnoid space

II VENTRAL SURFACE :-

- Ventral median fissure:- in midline, continuous with that of spinal cord.
- Anterolateral sulcus:- continuous with that of spinal cord, from it arise hypoglossal nerve, it separates pyramid from olive.
- Posterolateral sulcus:- separates olive from ICP, from it emerge cranial nerve IX, X & XI
- Pyramids:- contain pyramidal or corticospinal tract (descending fibers from ipsilateral cerebral cortex that cross over to form lateral corticospinal tract) "about 75-90% of fibers cross"

PONS :-

I DORSAL SURFACE :-

- It is the rostral 2/3 of ventricular floor.
- Lateral walls of rostral part of 4th ventricle $\therefore$ SCP & ICP
- Cerebral aqueduct: connect 4th ventricle with 3rd ventricle.

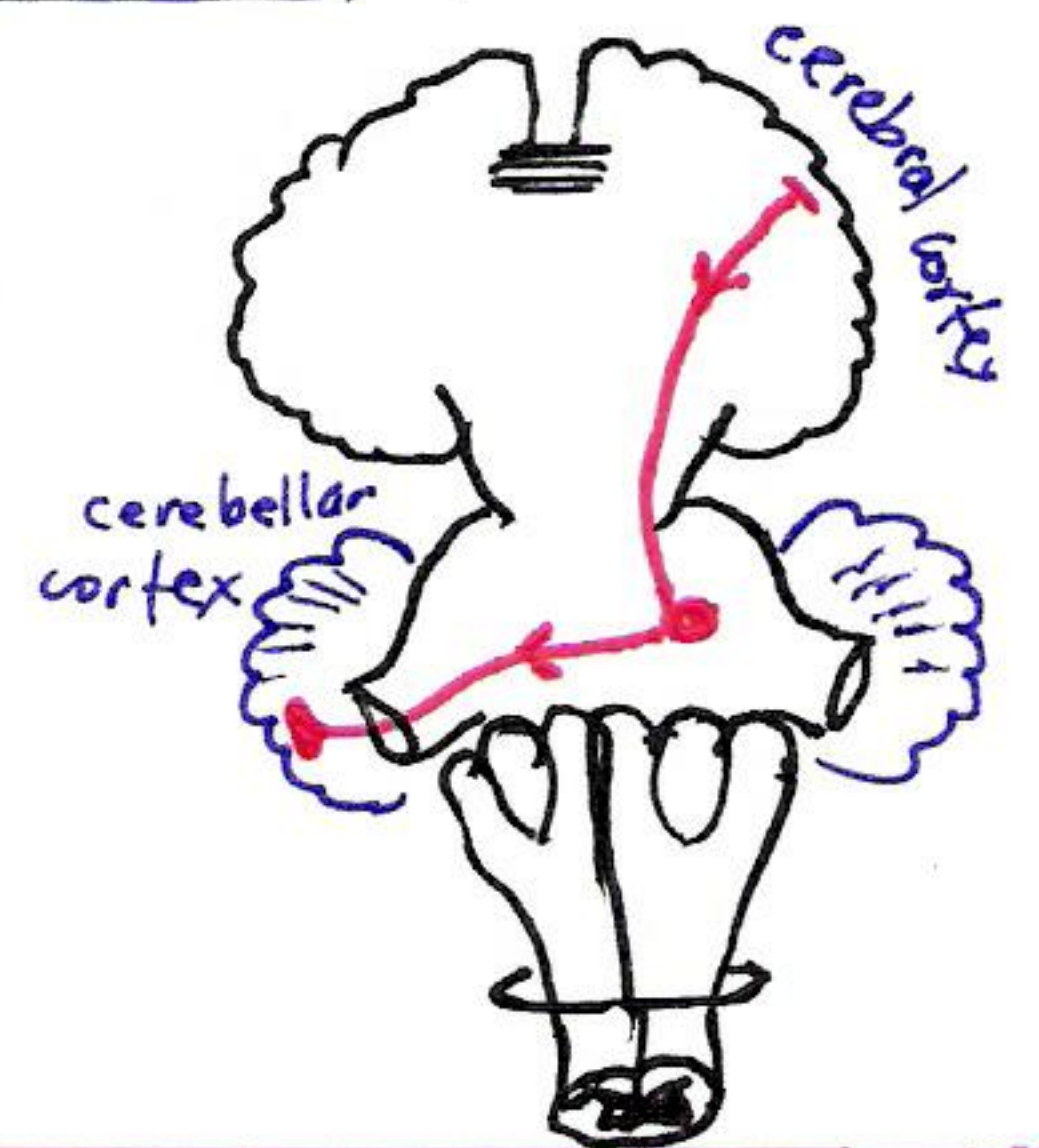
II VENTRAL SURFACE :-

- Median (basilar) sulcus: shallow groove in the middle line that lodges (contain) basilar artery.
- Abducent nerve (CN VI): emerge between pons & pyramid.
- Cranial nerves VII & VIII: emerge between pons & medull oblongata.
- Cranial nerve V (trigeminal): penetral MCP at its junction with Pons

NB:- • Ponto cerebellar (transverse pontine) fibers pass from ~~the~~ ventral Pontine nuclei through contralateral MCP to cerebellum

- Pontine nuclei receive corticopontine fibers from cerebral cortex including motor cortex, so pons connect cerebral & cerebellar cortices $\rightarrow$ coordination of movement.

- SCP = superior cerebellar peduncle.
- MCP = Middle " " "
- ICP = inferior " " "



N-B:- Reticular Formation:- (RF)

- It is a complex & heterogenous matrix of neurons in brain stem

- * function of RF:-**
- ① control over the level of consciousness.
 - ② Perception of pain.
 - ③ regulation of CVS & respiratory system

- * connection of RF:-**
- 1- cranial nerve nuclei
 - 2- cerebellum
 - 3- brain stem & spinal motor mechanisms, so it influence movement, posture & muscle tone

MIDBRAIN

I- DORSAL SURFACE :- (Tectum)

- There is 4 colliculi separated from each other by cruciform sulcus
- Superior colliculi (2) are elevations, part of visual system that connected to LGB (lat. geniculate body) by superior brachium quadrigeminum
- inferior colliculi (2) elevations, part of auditory system, that connected to MGB by inferior brachium quadrigeminum.
- CN IV emerge just ^{caudal} ~~lateral~~ to inferior colliculus.

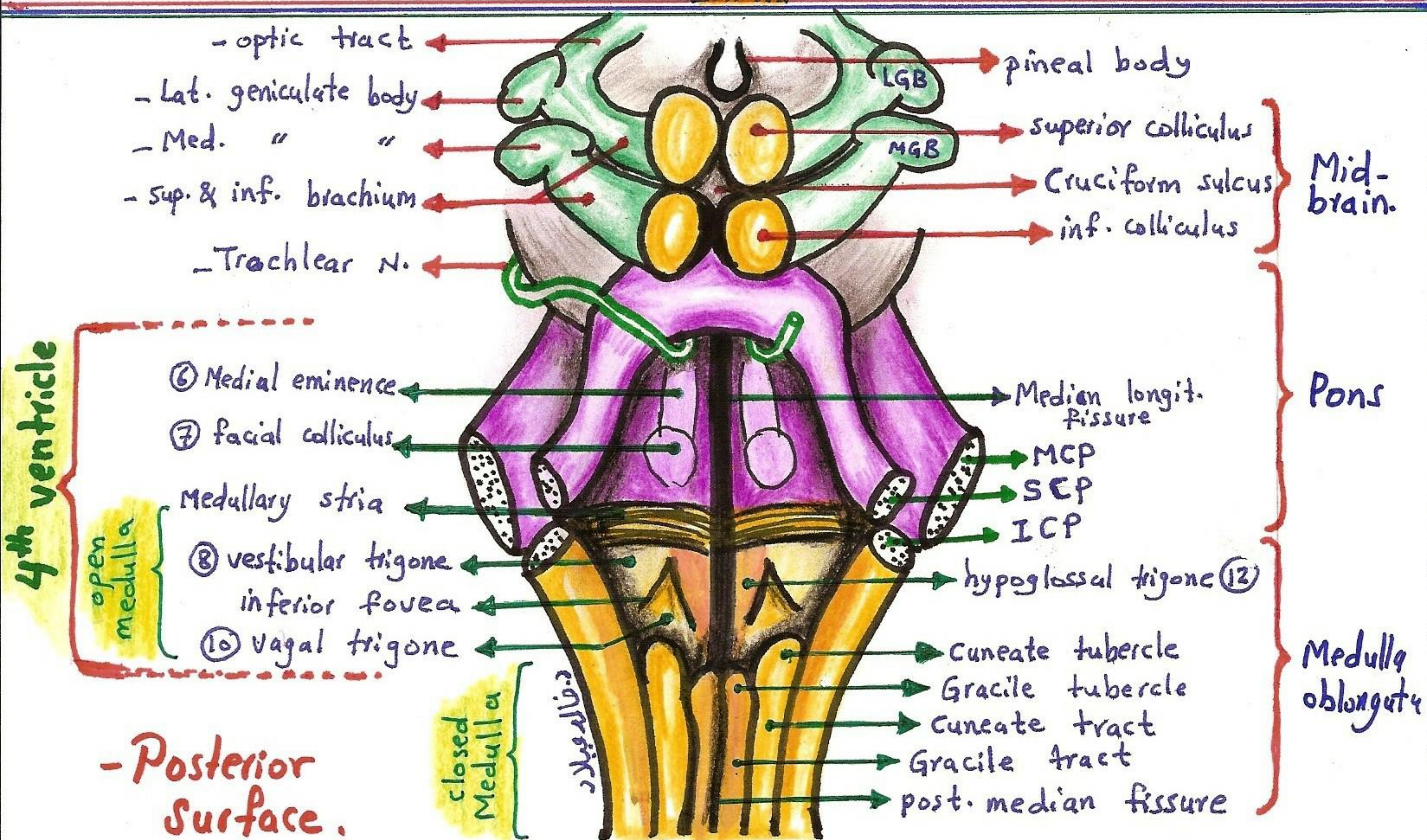
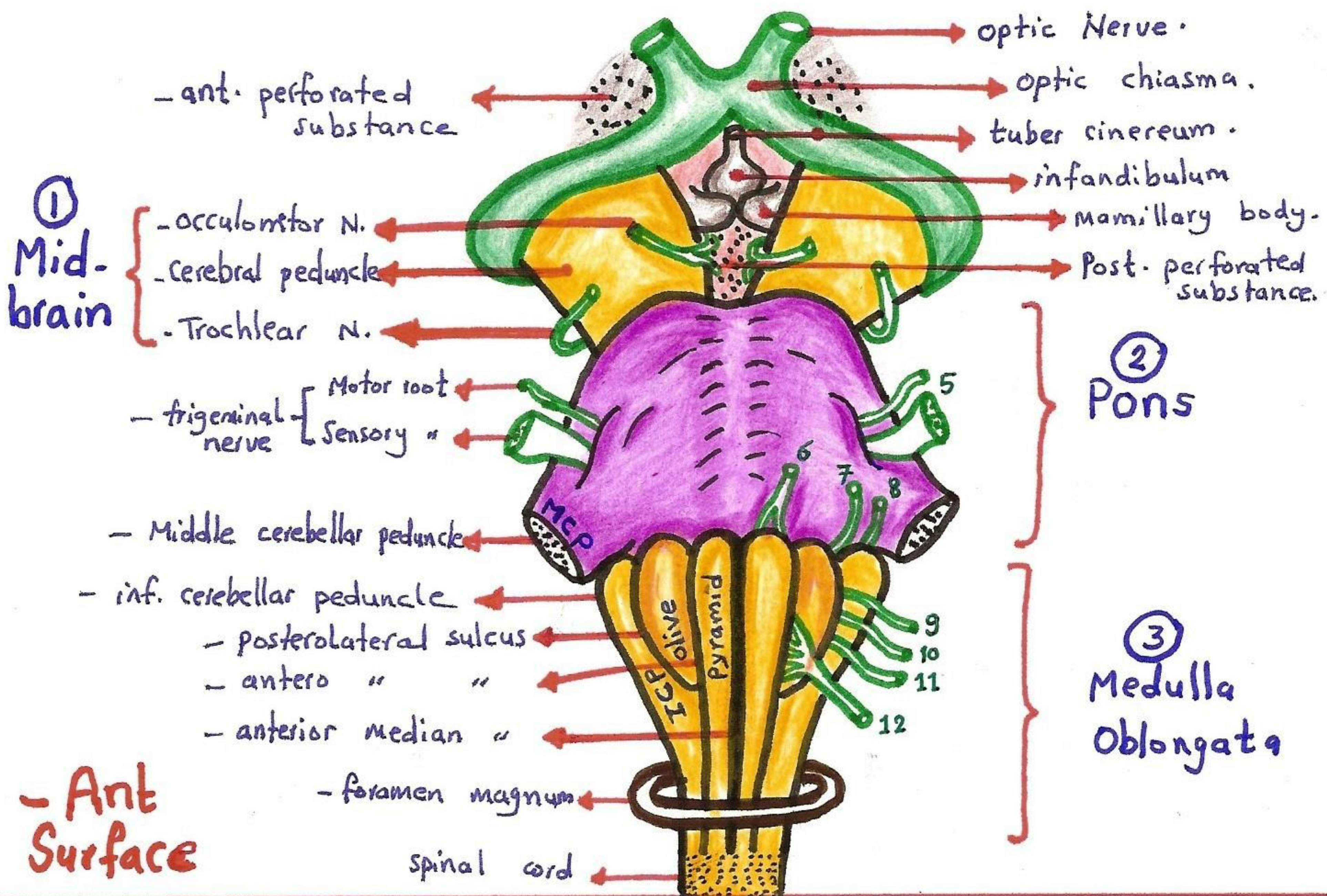
II- VENTRAL SURFACE :-

- ① Crus cerebri (basis pedunculi): descending fibers continuous rostrally with internal capsule of cerebral hemisphere.
- consists of corticobulbar & corticospinal fibers (to brain stem & sp. cord)
- ② Interpeduncular fossa: depression between 2 crura cerebri
- ③ Oculomotor N. (CN III): emerge from medial surface of crus cerebri

* Blood supply of brain stem :-

- 1- Medulla:- vertebral & posterior inferior cerebellar arteries.
- 2- Pons :- pontine branches of basilar artery.
- 3- Midbrain:- circle of willis arteries.

BRAIN STEM



* INTER-PEDUNCULAR FOSSA :

- It is a rhomboidal-shaped space at centre of base of brain.

* BOUNDARIES :

- Anteriorly → optic chiasma.
- Anterolateral → optic tracts.
- Posterolateral → Cerebral peduncle.
- Posteriorly → upper border of pons.

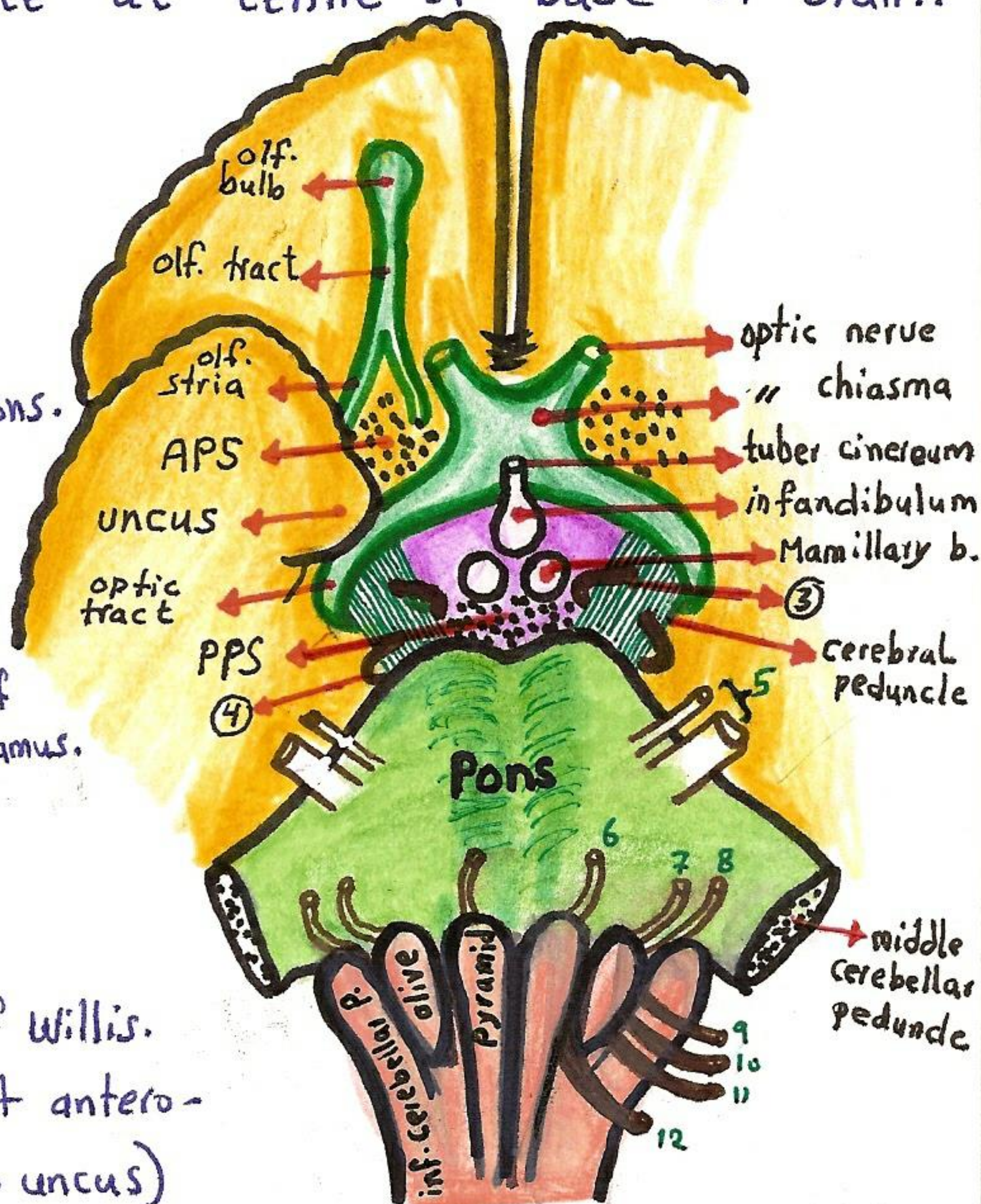
* CONTENTS :

- ① Tuber cinereum.
 - ② Infundibulum.
 - ③ Two mamillary bodies.
 - ④ Post. Perforated substance. ^{PPS}
 - ⑤ Oculomotor nerve.
- } parts of hypothalamus.

* N.B :- interped. fossa contains circle of Willis.

- Ant. Perforated substance ^{APS} present antero-lateral to the fossa (medial to uncus)

- Ant. Perf. substance is perforated by central branches of ACA & MCA
 - Post " " " " " " " " PCA.



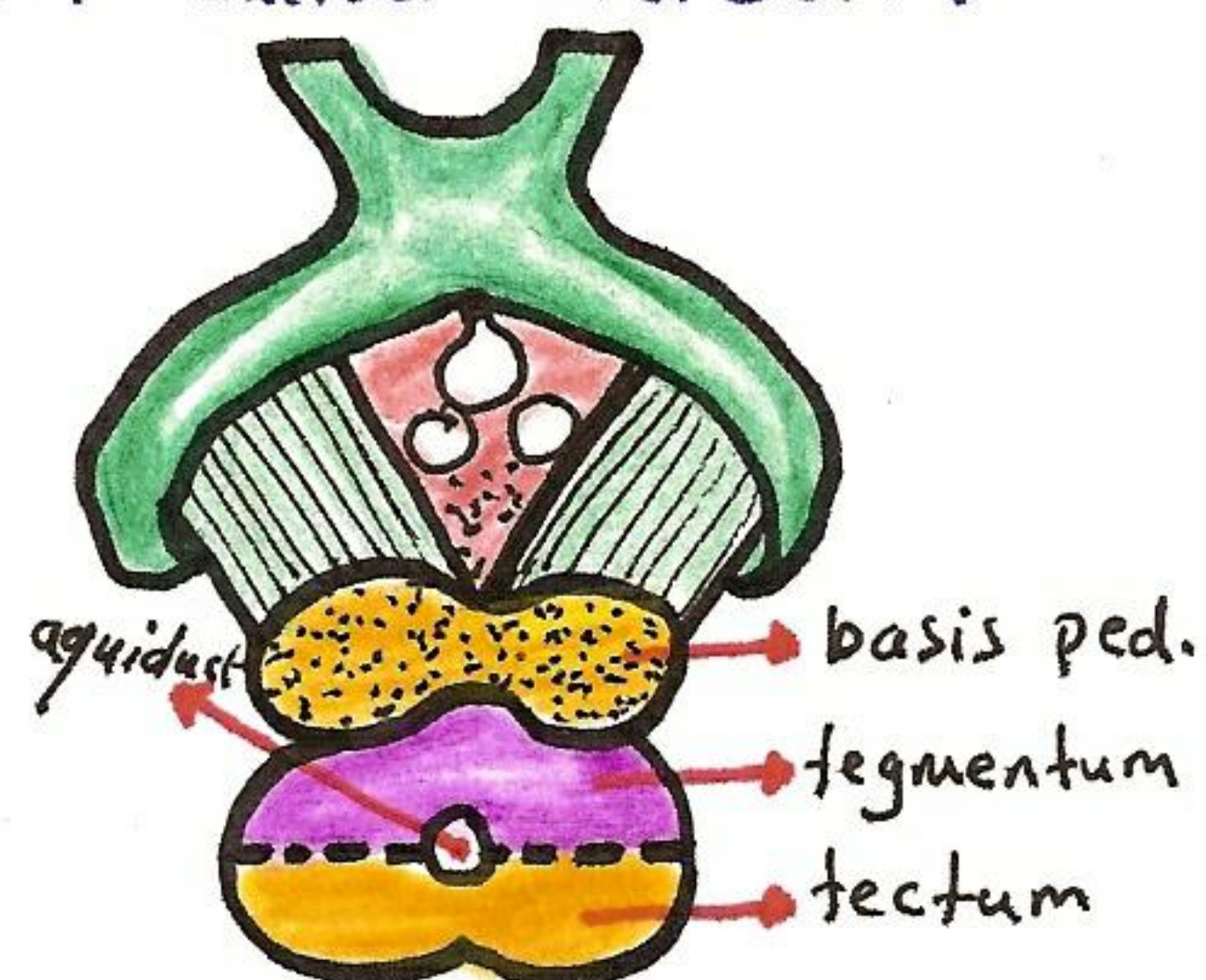
* INSULA:

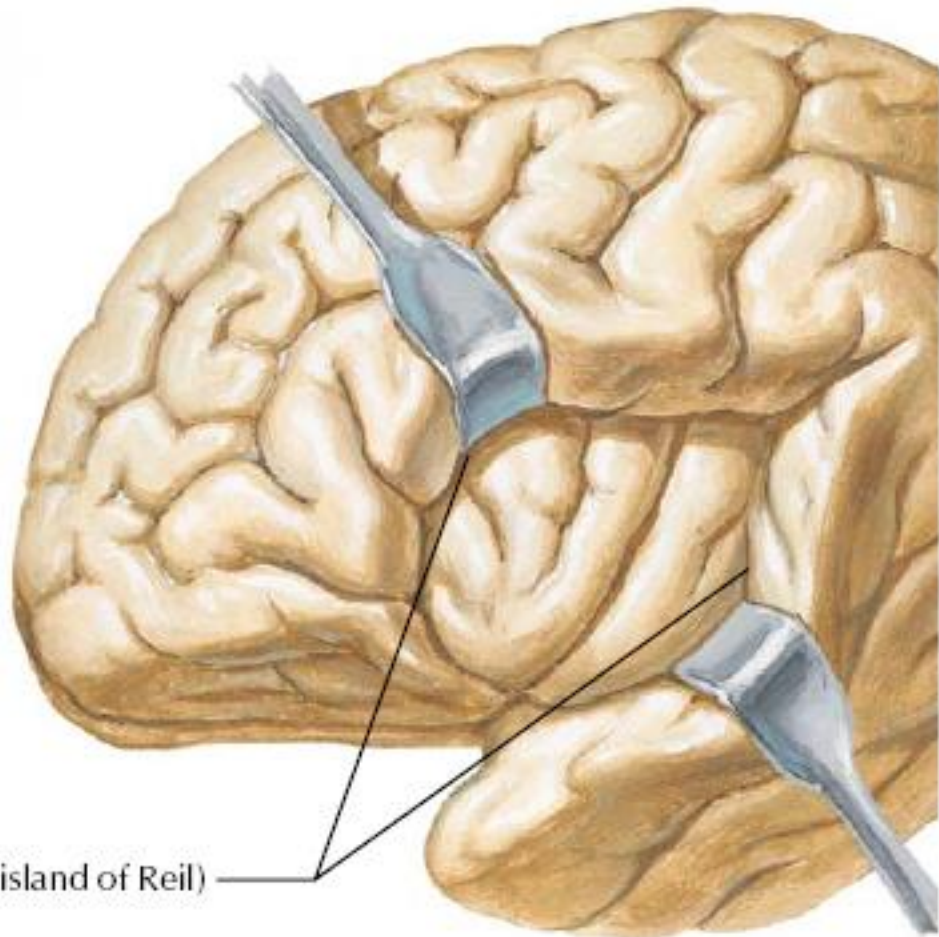
- It is the part of cerebral cortex hidden inside Lateral sulcus appears by separating the lips of Lat. sulcus, conical in shape.

* N.B :- The midbrain is part of brain stem that connects the Pons to diencephalon & contains inside duct called cerebral aquiduct (aquiduct of Sylvius).

- Cut section of Midbrain shows:

- ① tectum :- behind aquiduct of sylvius.
- ② tegmentum :- in front " " " "
- ③ basis pedunculi :- in front of tegmentum.





Insula (island of Reil)

CEREBELLUM

- The largest part of the hindbrain., lies dorsal to brain stem.
- It overlies 4th ventricle.
- connected to brain stem by 3 pairs of cerebellar peduncles
 - 1- SCP :- connect midbrain to cerebellum.
 - 2- MCP :- " Pons " "
 - 3- ICP :- " Medulla " "

* Function of cerebellum :-

- 1- Entirely motor. / coordinate movement.
- 2- operates at unconscious level.
3. equilibrium (balance).
- 4- influence posture & muscle tone.

* External features :-

- Two laterally located hemispheres joined in midline by vermis.
- Superior vermis :- raised forming midline ridges.
- inferior vermis :- lies in deep groove between hemispheres.
- surface of cerebellum is highly convoluted (folds or folia) and in between the folia lie the fissures.
- superior surface lies beneath tentorium cerebelli.
- the most important fissures are :-
 - ① Primary fissure :- on superior surface, separate ant. from Post. lobe
 - ② Posterolateral fissure :- on underside, demarcate flocculus & nodule
 - ③ horizontal fissure :- inside Posterior lobe, separate sup. & inf. surface of cerebellum & connects the 2 notches (ant. & Posterior)

* anatomical divisions of cerebellum :-

- ① Anterior lobe :- small, ~~located~~^{lies} anterior to primary fissure.
- ② Posterior lobe :- large, lies posterior to primary fissure
- ③ Flocculonodular lobe :- under MCP, separated from posterior lobe by posterolateral fissure.

* Internal structure of cerebellum :-

① outer grey matter :- (cerebellar cortex) :-

- highly convoluted with numerous folia.
- consists of cell bodies, dendrites & synaptic connections of most cerebellar neurones.

② Inner white matter :-

- consists of afferent & efferent fibers to & from cerebellum

* Cerebellar nuclei :-

- Lie deep within cerebellar white matter, above roof of 4th ventricle

- They are 4 pairs :- 1 - Fastigial nucleus.

2 - globose nuclei.

3 - emboliform nucleus.

4 - dentate nucleus. (Largest, seen by naked eye)

- cerebellar nuclei receive afferents from :-

1 - inferior olivary nuclei

2 - vestibular nuclei

3 - reticular nuclei.

4 - Pontine nuclei.

5 - spino cerebellar tracts (ventral & dorsal).

6 - Purkinje cells from cerebellum itself.

- Efferent fibers from cerebellar nuclei pass to :-

1 - reticular nuclei (medulla & pons).

2 - vestibular nuclei. (medulla & pons).

3 - Red nucleus (midbrain).

4 - ventral lateral nucleus of thalamus

* Arterial supply of cerebellum :-

1 - superior cerebellar (basilar)

2 - anterior inferior cerebellar (basilar).

3 - posterior inferior cerebellar (vertebral).

* Functional anatomy of cerebellum

① Archicerebellum:- oldest portion.

- consists of : 1- Flocculonodular lobe.
2 - Fastigial nuclei
- concerned with maintaining equilibrium.
- connected to vestibular & reticular nuclei through ICP.

② Paleocerebellum:-

- consists of : 1 - vermis.
2 - Para vermis.
3 - globose nuclei.
4 - emboliform nuclei
- influences muscle tone & posture.
- contains:- [1]- afferent from dorsal & ventral spino-cerebellar tract neurons enters through ICP & SCP respectively
- [2]- efferents from globose & emboliform nuclei, project via SCP to contralateral red nucleus of midbrain giving descending rubrospinal tract.

↑ carry information from ms. joint, skin

③ Neo-cerebellum:-

- Consists of : 1- dentate nuclei.
2 - remainder of cerebellar hemisphere
- concerned with muscular coordination
- contains principal afferent pathway: consist of ponto-cerebellar fibers
- the efferents of dentate nucleus:-
 - form major part of SCP, fibers decussate in midline before reaching red nucleus.
 - some fibers relay in red nucleus with rubrothalamic ^{cells} ↑
 - most bypass red nucleus, pass directly to motor cortex of frontal lobe.
- so, neo-cerebellum coordinate movement by corticospinal and corticobulbar pathways.

(21)

* Applied anatomy of cerebellum :-

- cerebellar lesions cause incoordination of :-
 - 1- upper limbs (intension tremors) = trembling.
 - 2- lower limbs (cerebellar ataxia) = loss of ability to coordinate voluntary movements.
 - 3- speech (dysarthria) = inability to pronounce.
 - 4- Eyes (nystagmus) = to and fro movements of the eyes.

* Cerebellar Peduncles :-

① ICP :- (restiform body) :-

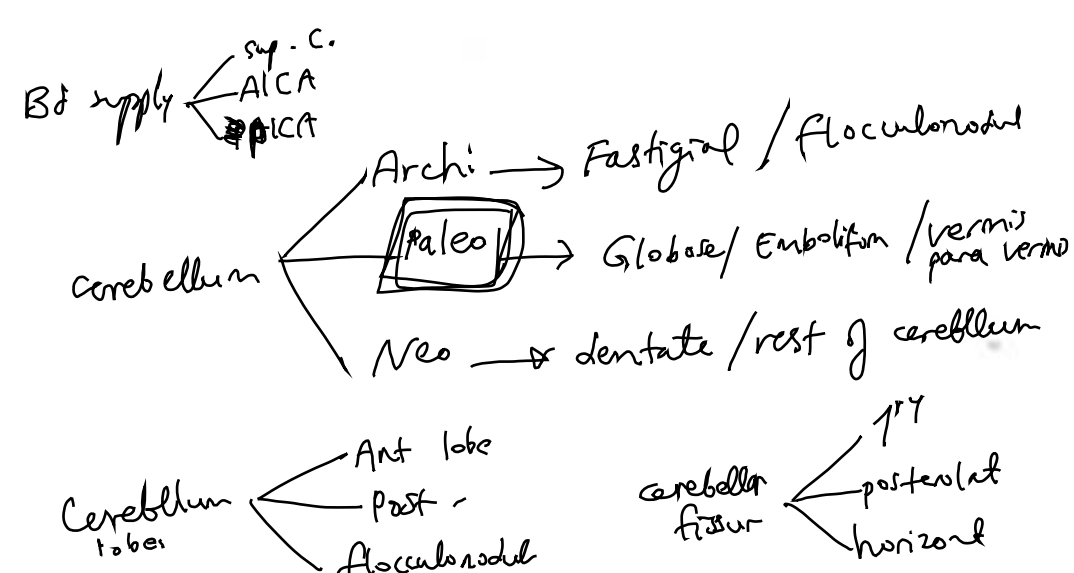
- afferent fibers :-
 - ① - dorsal spino-cerebellar tract.
 - ② - olivo-cerebellar tract.
 - ③ - vestibulo-cerebellar tract.
- efferent fibers :-
 - ① - cerebello-vestibular tract.
 - ② - cerebello-olivary tract.

② MCP :- (Largest) :-

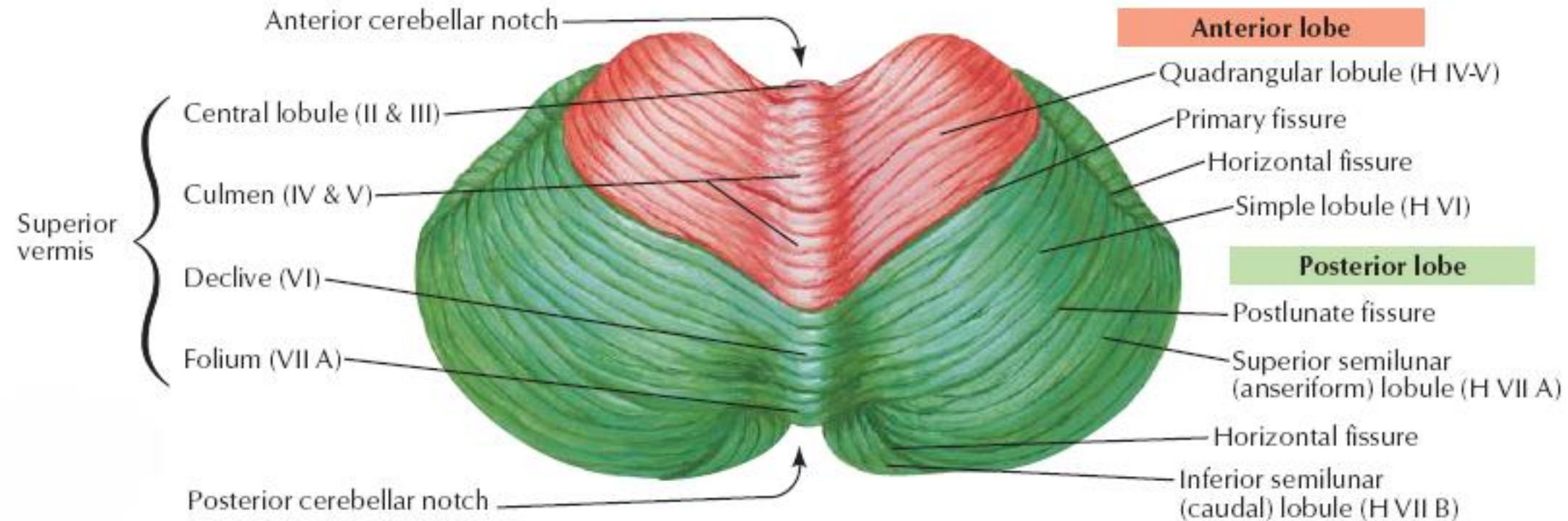
- afferent fibers : (almost only afferent) → cerebro-cerebellar connections

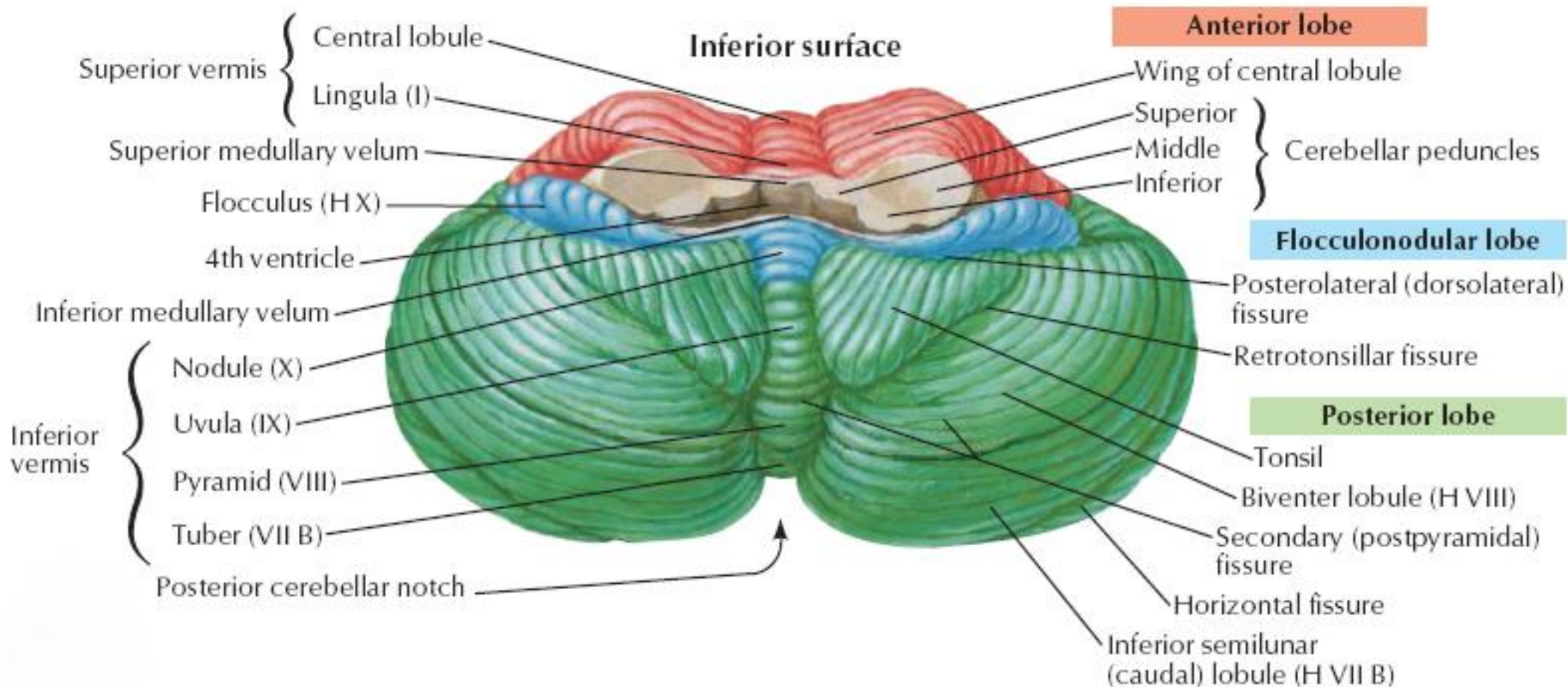
③ SCP :- efferent : mainly axons of cells of dentate nucleus of cerebellum to red nucleus of opposite side of midbrain.

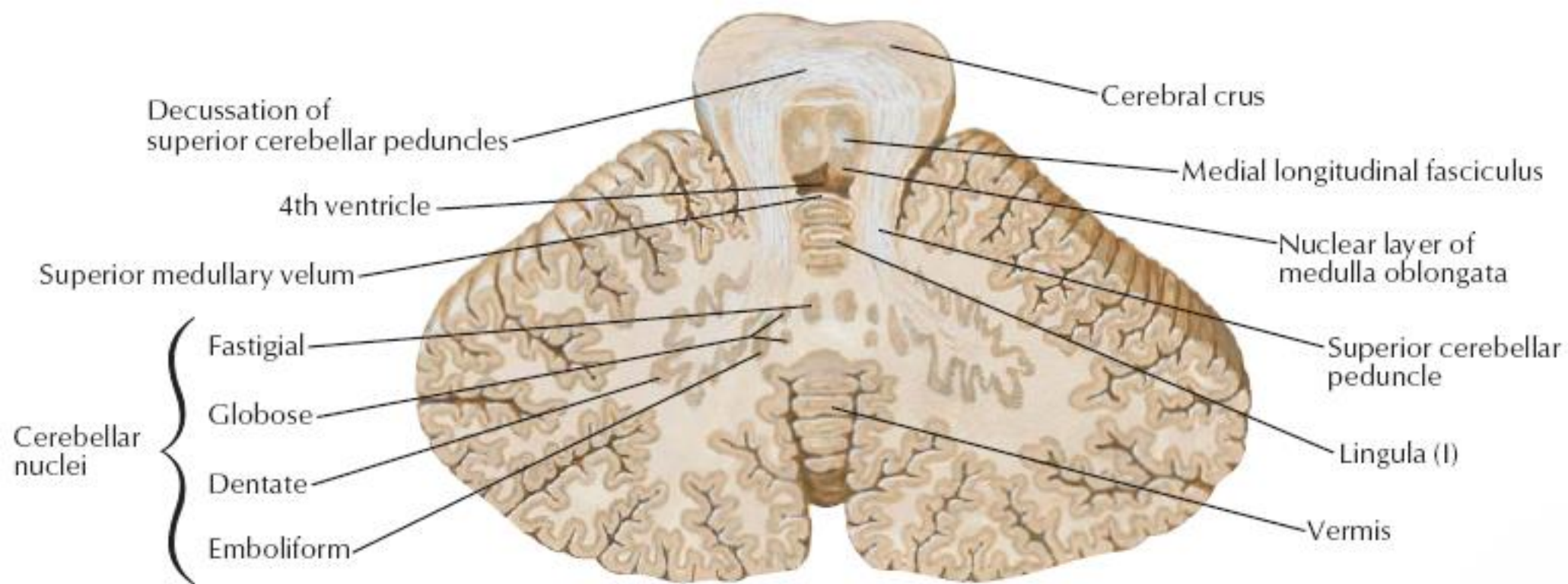
- afferents : Ventral spino-cerebellar tract.



Superior surface







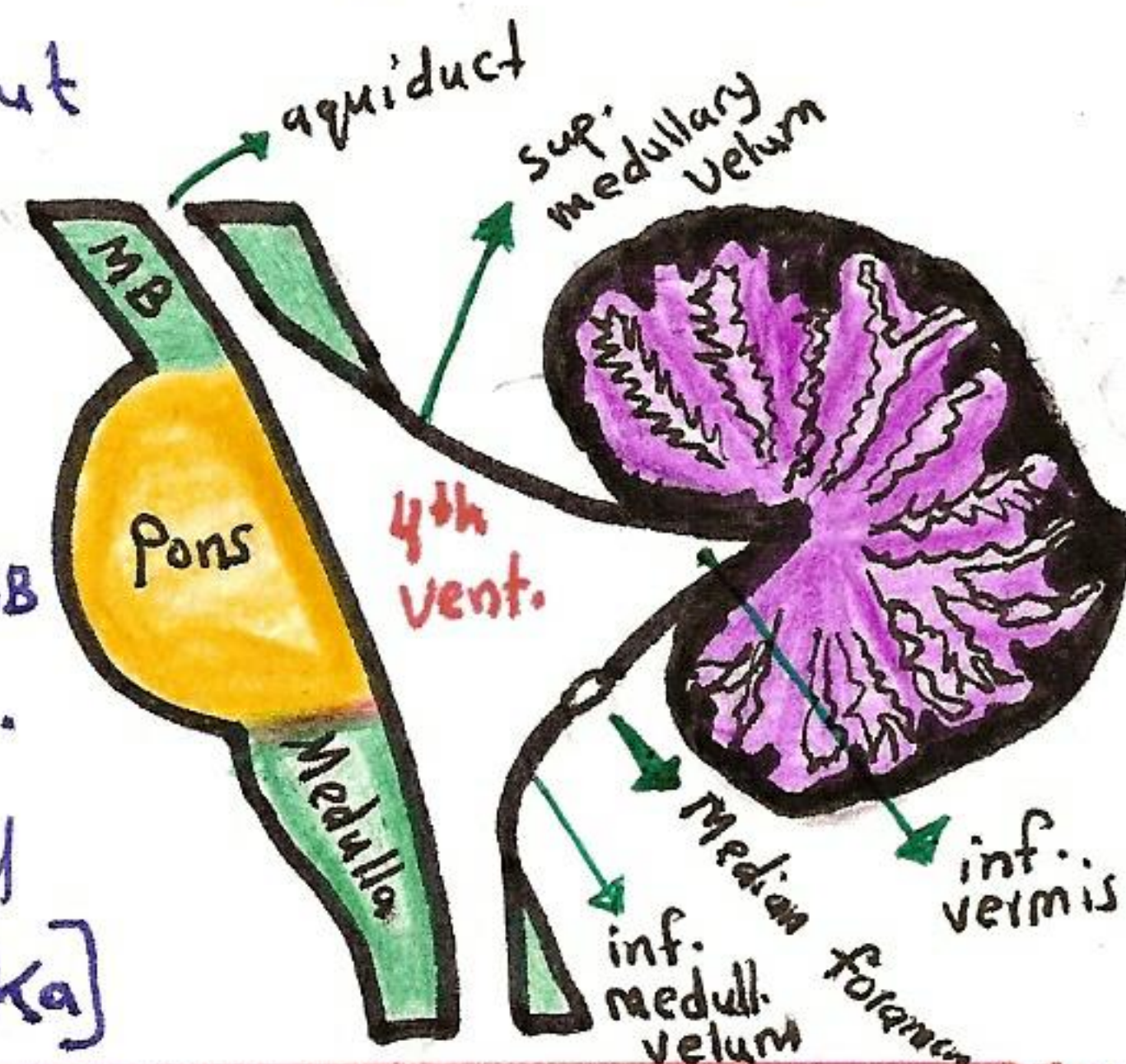
Section in plane of superior cerebellar peduncle

FOURTH VENTRICLE

- It is the cavity of the hindbrain between the cerebellum (Posteriorly) & pons and open medulla (anteriorly).
- It is diamond-shaped (from behind) but tent-shaped (when seen from side)

* ANGLES OF THE VENTRICLE :

- ① Superior angle → continuous with aquiduct of MB
- ② inferior angle → continuous with central canal.
- ③ Two Lat angle → continuous with subarachnoid space through [foramen of luschka]



N.B.: 4th ventricle has 3 foramina connected to subarachnoid space
Two lateral aperture [F. of luschka] & one median aperture (f. of Magendi) present in the roof [in inferior medullary velum]

* BOUNDARIES OF VENTRICLE :

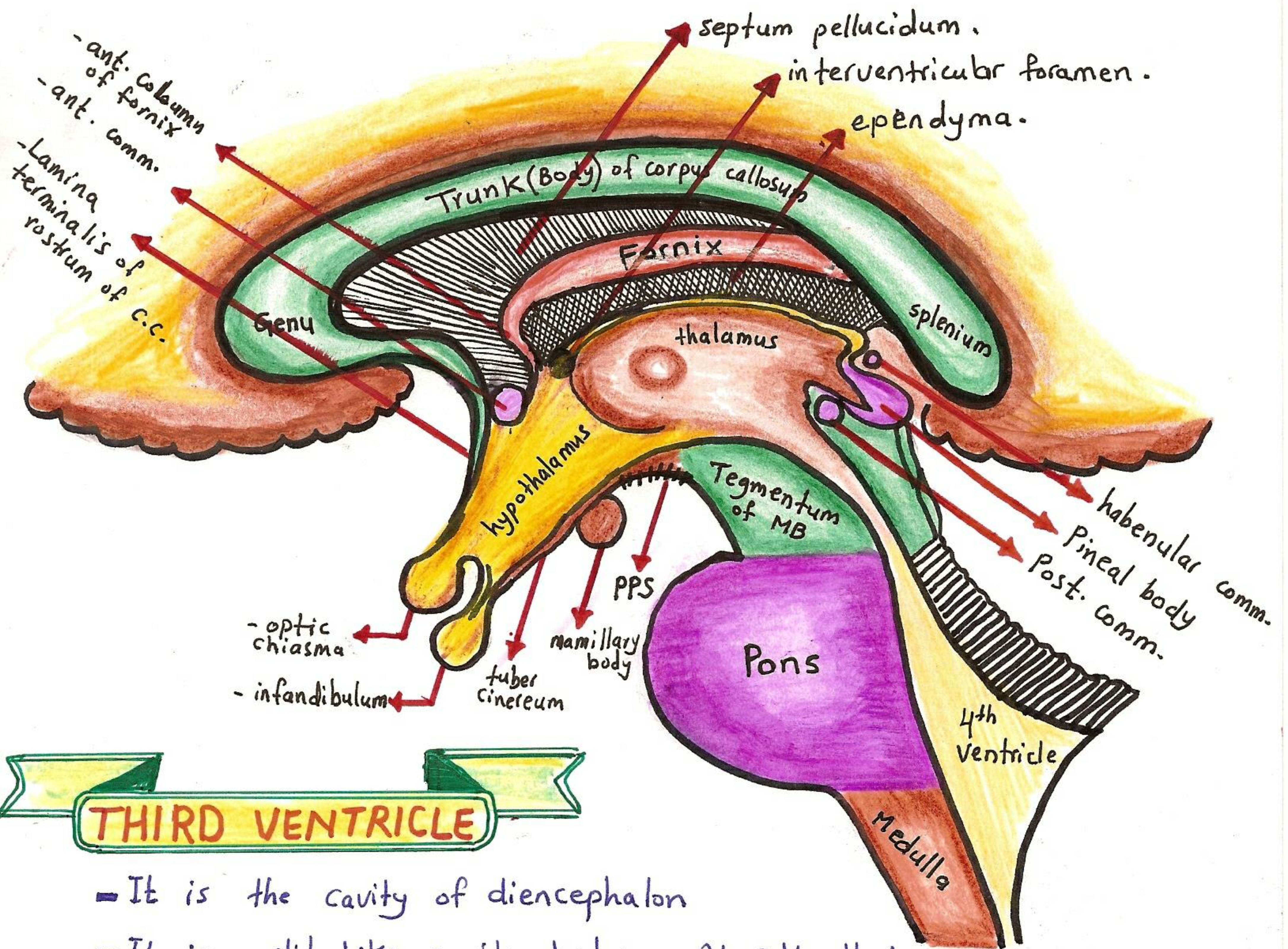
- ① Upper lateral : superior cerebellar peduncle.
- ② Lower-lateral : inferior cerebellar peduncle, Cuneate & gracile tubercles.

* FLOOR OF VENTRICLE :

- ① Upper part [above medullary stria] (Pontine part): formed by: superior fovea, medial eminence (abducent nucleus) & facial colliculus.
 - ② Lower part [below medullary stria] (Medullary part = open medulla): formed by: inferior fovea (groove), vagal trigone (below fovea), vestibular trigone (above & lat. to fovea) and hypoglossal trigone (above & medial to fovea).
- NB: the floor is divided into Rt & Lt by Median longitudinal fissure.

* ROOF OF VENTRICLE :

- ① Upper part : superior medullary velum (sheet ^{of white matter} bet. two sup. cerebellar peduncle).
- ② Lower " : inferior " " " (" " " inf. " ").
- ③ Middle part : inferior vermis of cerebellum

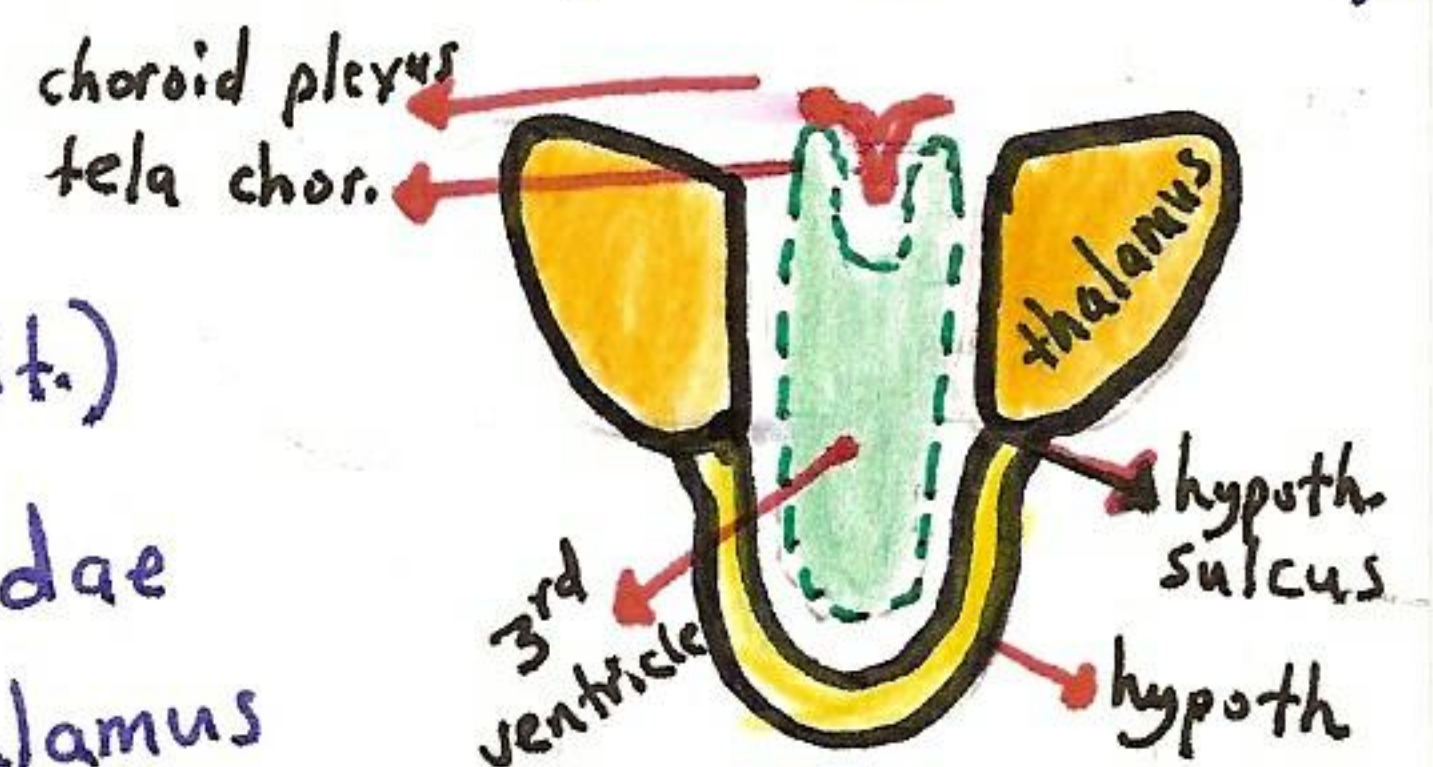


THIRD VENTRICLE

- It is the cavity of diencephalon
- It is a slit like cavity between Rt & Lt thalamus.
- It communicates below with 4th ventricle via cerebral aqueduct & on each side with lateral ventricle via interventricular foramen (which bounded anteriorly by ant. column of fornix & post. by thalamus)

* BOUNDARIS :

- * **FLOOR** : hypothalamus (ant.) & tegmentum of MB (post.)
- * **ROOF** : ependyma which lines the tela choroidea
- * **LATERAL WALL** : thalamus, hypothalamic sulcus & hypothalamus
- * **POSTERIOR** " : habenular commissure, pineal body & post. comm. (from above downward)
- * **ANTERIOR** " : ant. column of fornix, ant. commissure & Lamina terminalis (stretching from rostrum of corpus callosum to optic chiasma).



[NB] hypothalamus in floor consists of ① optic chiasma ② infundibulum & tuber cinereum ③ mamillary body ④ post. perforated substance

- Recesses of 3rd ventricle are ① optic recess ② infundibular recess. ③ Pineal " ④ suprapineal " "

DIENCEPHALON

- Lies between the brain stem & cerebral hemispheres.
- Continuous with rostral part of midbrain.
- Consists of
 - ① - Thalamus.
 - ② - hypothalamus.
 - ③ - Epithalamus.
 - ④ - subthalamus.
 - ⑤ - Metathalamus (Part of lateral nucleus of thalamus).

Thalamus :-

- The largest part of diencephalon, covered by cerebral hemispheres.
- Consists of
 - Nuclei transmit sensation to sensory cortices.
 - Nuclei receive impulses from cerebellum & basal ganglia and interface with motor regions of frontal lobe.
 - Nuclei having connections with associative & limbic areas of the cortex.
- External features of thalamus :-
 - Looks like small hen's egg.
 - has 2 large ovoid masses of grey matter.
 - has 2 ends & 4 surfaces :-
 - Posterior end :- overhangs superior colliculus & brachium, inferiorly related to MGB & LGB.
 - Anterior end :- narrow & forms Post. boundary of the interventricular foramen.
 - Superior surface :- (dorsal aspect):
 - Lateral part forms floor of body of lateral ventricle.
 - Medial part covered with tela choroidea of 3rd ventricle.
 - Inferior surface :- (ventral aspect) :- formed of :-
 - subthalamus, hypothalamus & midbrain (caudal to it).

- Medial surface of thalamus:-

- forms superior part of lateral wall of 3rd ventricle, connected to opposite thalamus by interthalamic adhesion (massa intermedia), below it hypoth. sulcus.

- Lateral surface:-

- Posterior limb of internal capsule (separating it from lentiform ^{nucleus} N.)
- anterolateral: head of caudate nucleus.

Hypothalamus:-

- Lies below thalamus, ventro-medial to subthalamus.
- Consists of: ① Tuber cinereum:- small midline elevation, extends from its apex infundibulum or pituitary stalk.
- ② Mamillary bodies:- rounded elevations on either side of midline, contain mamillary nuclei.
- Connected with limbic system controlling activity of autonomic nervous system, neuroendocrine function (by pituitary gland connection)

Subthalamus:-

- Lies below thalamus, dorso-lateral to hypothalamus.
- Consists of: ① Subthalamic nucleus:- which is connected with globus pallidus & substantia nigra → control movement
- ② Zona incerta:- rostral extension of the brain stem reticular formation.
- Fibers that traverse subthalamus & enter thalamus include:-
 - Ascending sensory projections:- medial lemniscus, spinothalamic tracts & trigeminothalamic tracts.
 - Cerebellothalamic fibers from medial segment of globus pallidus.

Epithalamus :-

- Lies immediately rostral to superior colliculus of Midbrain
- consists of :-
 - ① Pineal gland :- endocrine gland, functions are :-
 - synthesis of hormone melatonin.
 - control sleep/waking cycle.
 - regulate the onset of puberty.
 - ② Habenular nuclei - connected to limbic system.

Metathalamus :-

- consists of :
 - ① Lat. geniculate body (2) "LGB" - contain LG nucleus
part of visual system.
 - ② Med. geniculate body (2) "MGB" contains MG nucleus
part of auditory system.

Notes :-

- * Basal ganglia consists of :
- ① Caudate nucleus.
 - ② Claustrum.
 - ③ Globus pallidus.
 - ④ Putamen.
 - ⑤ Amygdaloid body.

- * Limbic system consists of :
- ① Cingulate gyrus.
 - ② para hippocampal gyrus.
 - ③ hippocampus.
 - ④ Amygdala.

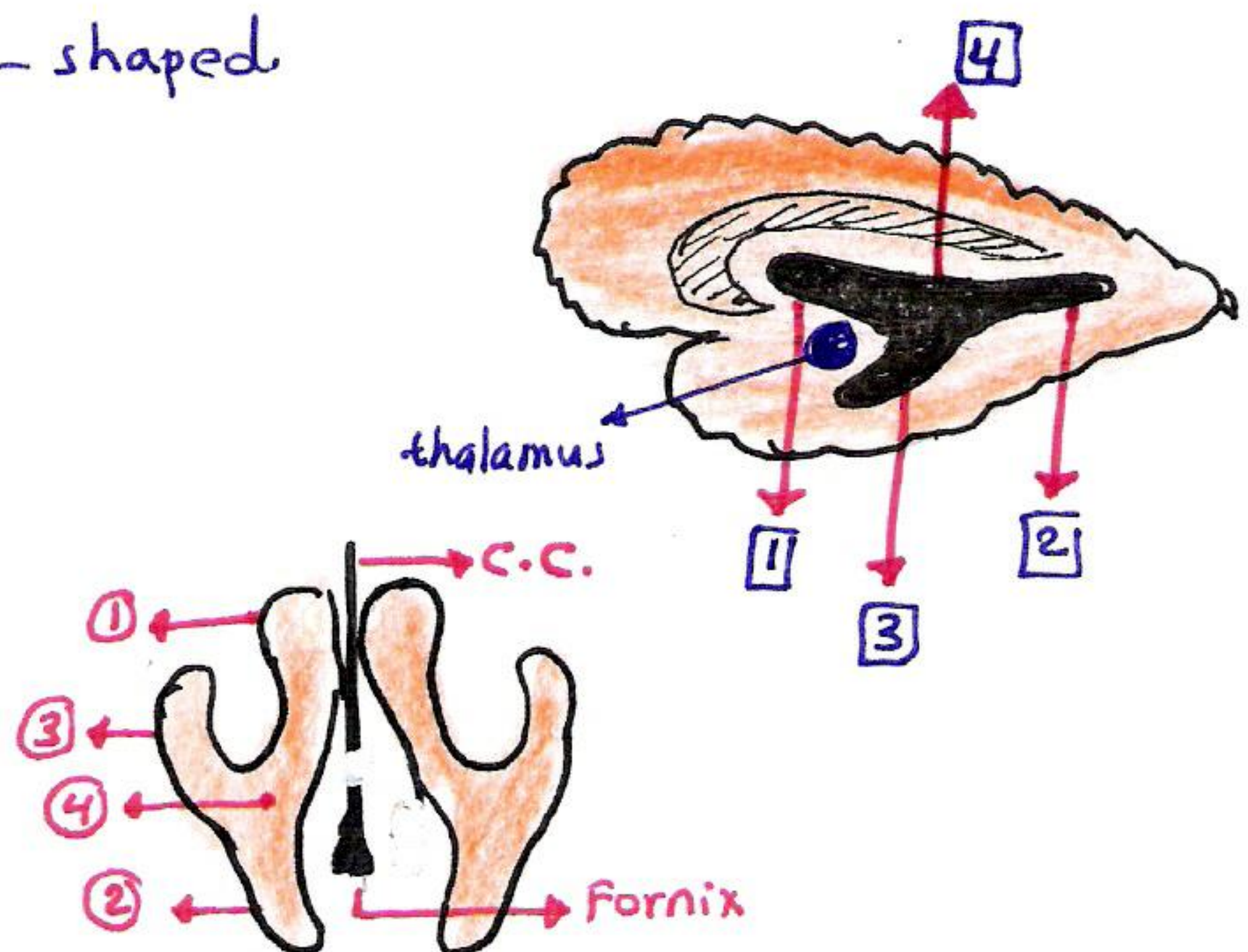
LATERAL VENTRICLE

* Site :-

- Located within the cerebral hemisphere, communicates with the 3rd ventricle through interventricular foramen.
- Shape: is approximately C-shaped.

* Consists of :-

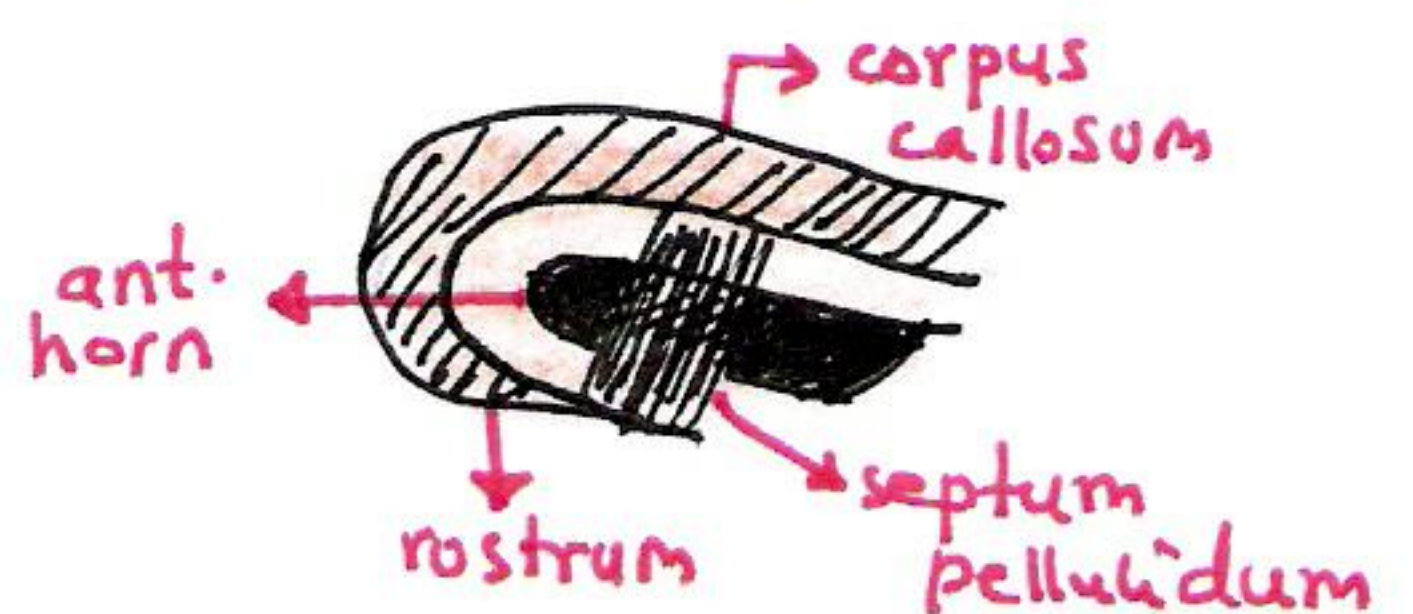
- 1- Anterior (Frontal) horn.
- 2- Posterior (occipital) horn.
- 3- Inferior (Temporal) horn.
- 4- Body (central part).



① * Anterior horn :-

- Anterior to interventricular foramen, inside frontal lobe

- Roof :- corpus callosum (C.C.)
- Floor :- rostrum of C.C.
- Medial wall :- septum pellucidum.
- Lateral wall :- head of caudate nucleus.

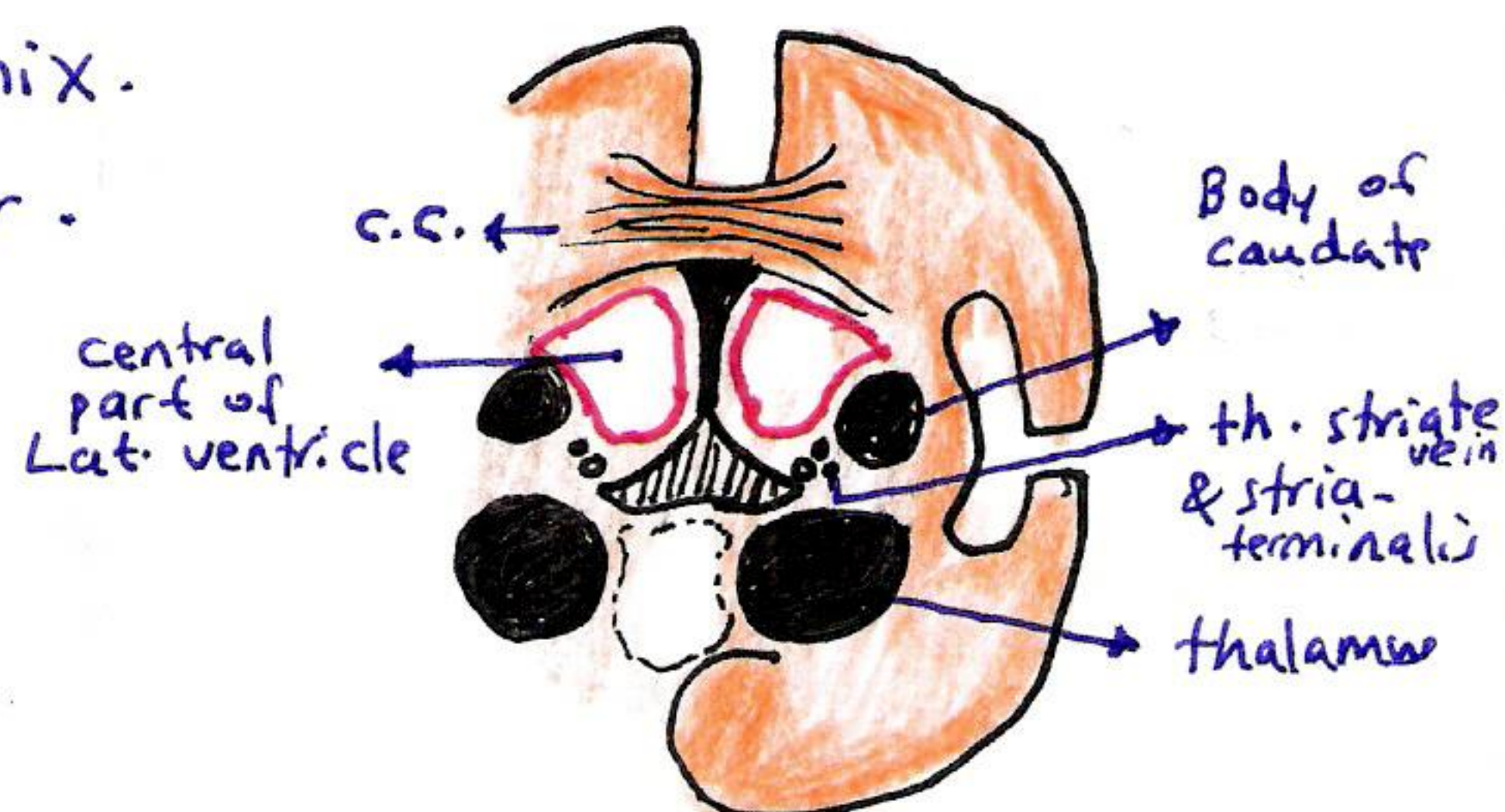


septum pellucidum is a thin sheet between C.C. & fornix in midline separates ant. horns & central parts of the 2 lateral ventricles.

② * Body (central part) :-

- Posterior to interventricular foramen, to splenium of corpus callosum

- Roof :- body of C.C.
- Floor :- body of caudate, stria terminalis, thalamus & thalamostriate vein
- Medial wall :- septum pellucidum, fornix.
- Lateral wall :- meeting of roof & floor.

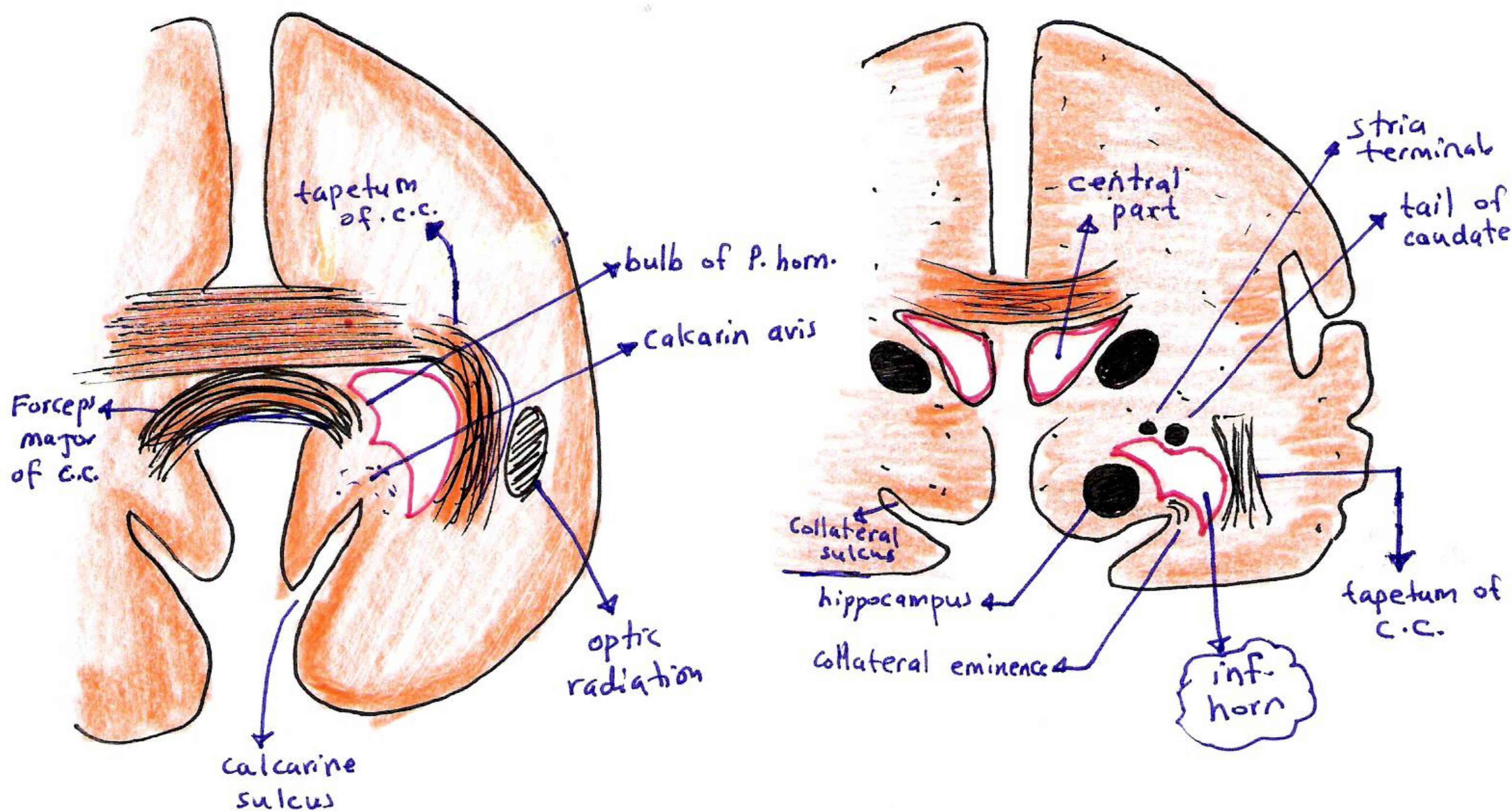


[3] * Posterior horn of lat. ventricle.

- extends from splenium to occipital pole
- Roof & lat. wall :: tapetum of C.C. & optic radiation
- Floor & Med. wall = 2 long elevations:
 - a- bulb of post. horn (formed by forceps major of C.C.)
 - b- Calcar avis (produced by calcarine sulcus).

[4] * Inferior horn.

- Lies inside temporal lobe
- Roof :: stria terminalis, tail of caudate & amygdala.
- Lateral wall: tapetum of C.C.
- Floor: a- Collateral eminence (produced by collateral sulcus).
b- hippocampus
c- Fimbria (axons of hippocampus continuous with crus of fornix).



BASAL GANGLIA

* Definition :-

- Number of nuclear masses inside cerebral hemisphere.
- They are part of extrapyramidal motor system.

* major components are :-

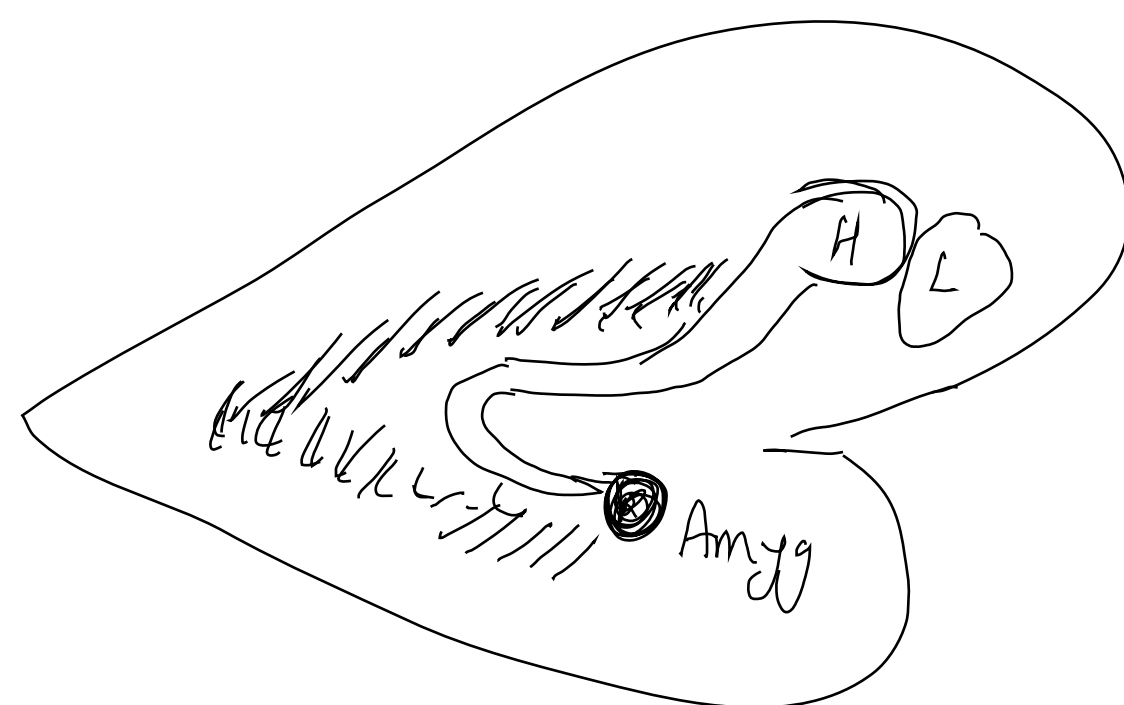
- 1- Caudate nucleus.
- 2- Putamen.
- 3- globus pallidus.
- 4- Amygdala (inside temporal lobe, part of limbic system).
- 5- Claustrum (unknown function).

NB: Corpus striatum consists of :-

- 1- caudate nucleus.
- 2- Putamen.
- 3- globus pallidus.
 - anatomically & functionally closely related to each other.
 - Control posture & movement.
 - Connected to thalamus, subthalamus, substantia nigra of MB

Caudate nucleus consists of :-

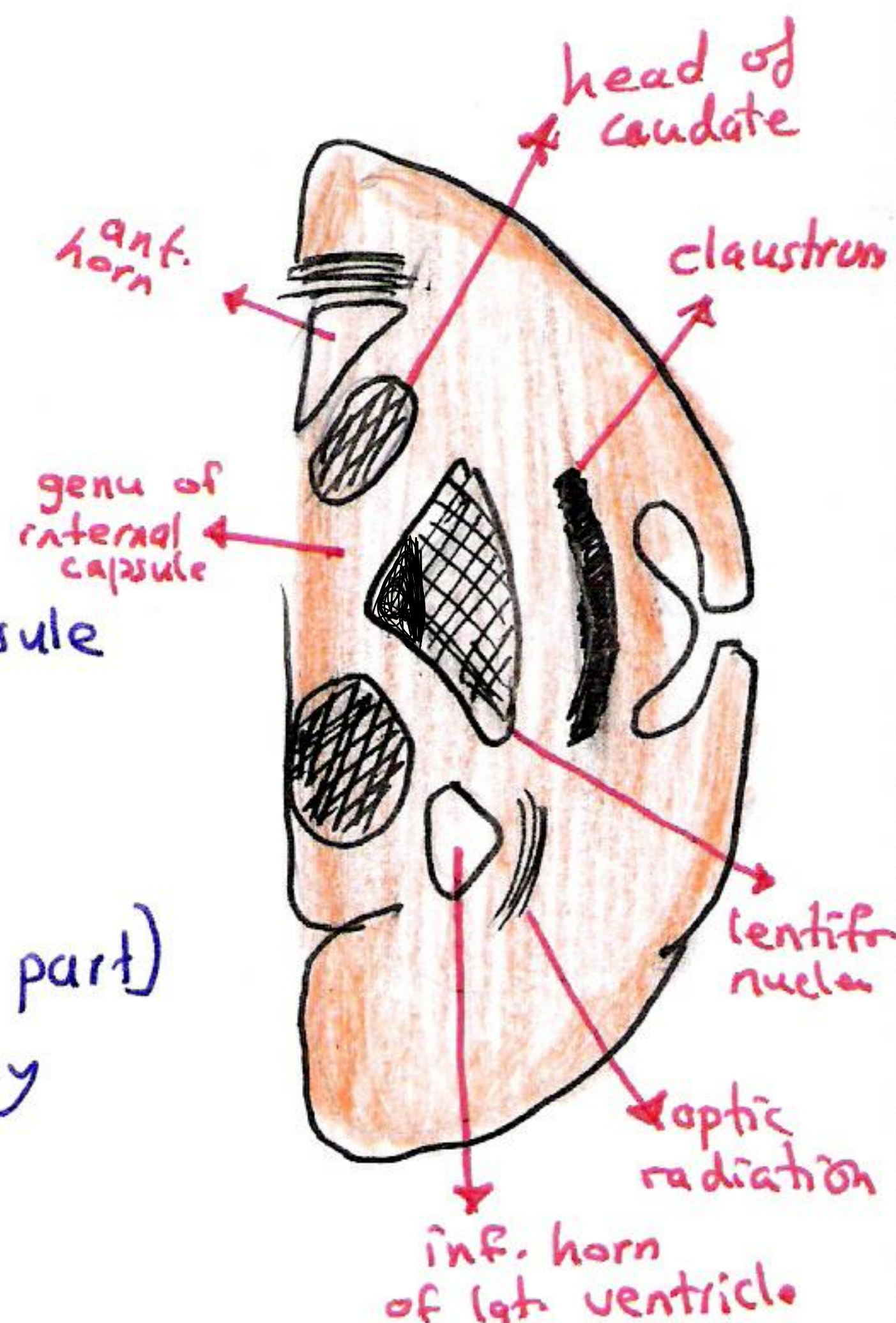
- 1- head :- Lies in lateral wall of anterior horn of lateral ventricle
 - fused with Lentiform nucleus at its anterior end.
- 2- body :- Lies in floor of central part of lateral ventricle.
- 3- tail :- passes in roof of inferior horn " " " "
 - ends in amygdaloid nucleus



* Lentiform (Lenticular) nucleus *

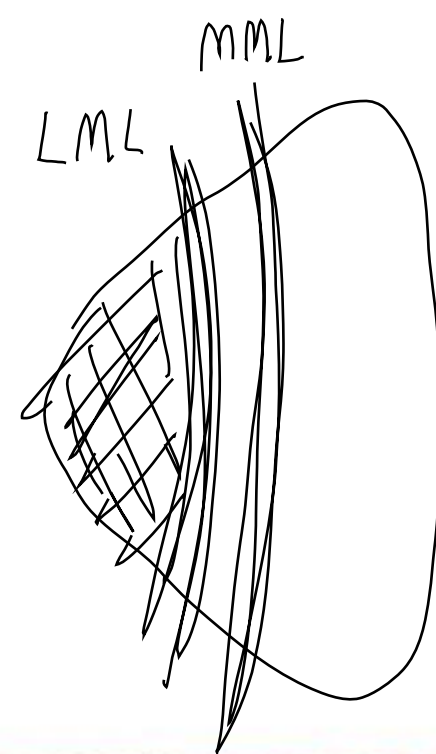
- has 3 sides ; Convex lateral surface & two other surface against genu of internal capsule.
- separated from claustrum by external capsule
- Lentiform nucleus consists of :-

- ① Putamen (larger, darker, lateral part)
 - ② Globus pallidus (smaller, lighter, medial part)
- they are close together separated by lateral medullary lamina.



* Globus pallidus :- consists of.

- ① lateral segment (larger).
 - ② Medial segment (smaller).
- separated by medial medullary lamina



* Substantia innominata *

- basal part of rostral forebrain, under corpus striatum.
- contains several groups of neurones one of them nucleus basalis (of Meynert).
- project widely to cerebral cortex.
- utilise acetylcholine as neurotransmitter.
- undergo degeneration in Alzheimer's disease.

WHITE MATTER OF CEREBRAL HEMISPHERE

* Classification of the fibers :-

① Association fibers:-

- Connect cortex sites within same cerebral hemisphere.

② Commissural fibers:-

- Connect sites of one cerebral hemisphere to other.

③ Projection fibers:-

- Pass between cerebral cortex & subcortical structures such as thalamus, striatum, brain stem & spinal cord.

I. Association fibers :-

① Short ass. fibers:-

- connect areas of cortex to ^{gyri to one another} adjacent areas (U-fibers) (arcuate fibers)

② Long ass. fibers:-

- connect distant area to cerebral cortex through white matter
- they connect primary sensory areas (in parietal, temporal & occipital lobes) to association areas of cerebral cortex.
 - 1- superior longitudinal fasciculus:- interconnect frontal & occipital lobes
 - 2- Arcuate fasciculus:- interconnect frontal & ~~occipital~~ lobes
(important for language). → Temporal
 - 3- Inferior longitudinal fasciculus:- interconnect temporal & occipital
(important for visual recognition).
 - 4- Uncinate fasciculus:- connect temporal to frontal (ant. & inf. parts of frontal)
(important for behaviour regulation).
 - 5- Cingulum:- Lies within cingulate gyrus, courses around corpus c.
connecting frontal & parietal lobes with the parahippocampal and adjacent temporal gyri

II. Commissural fibers :-

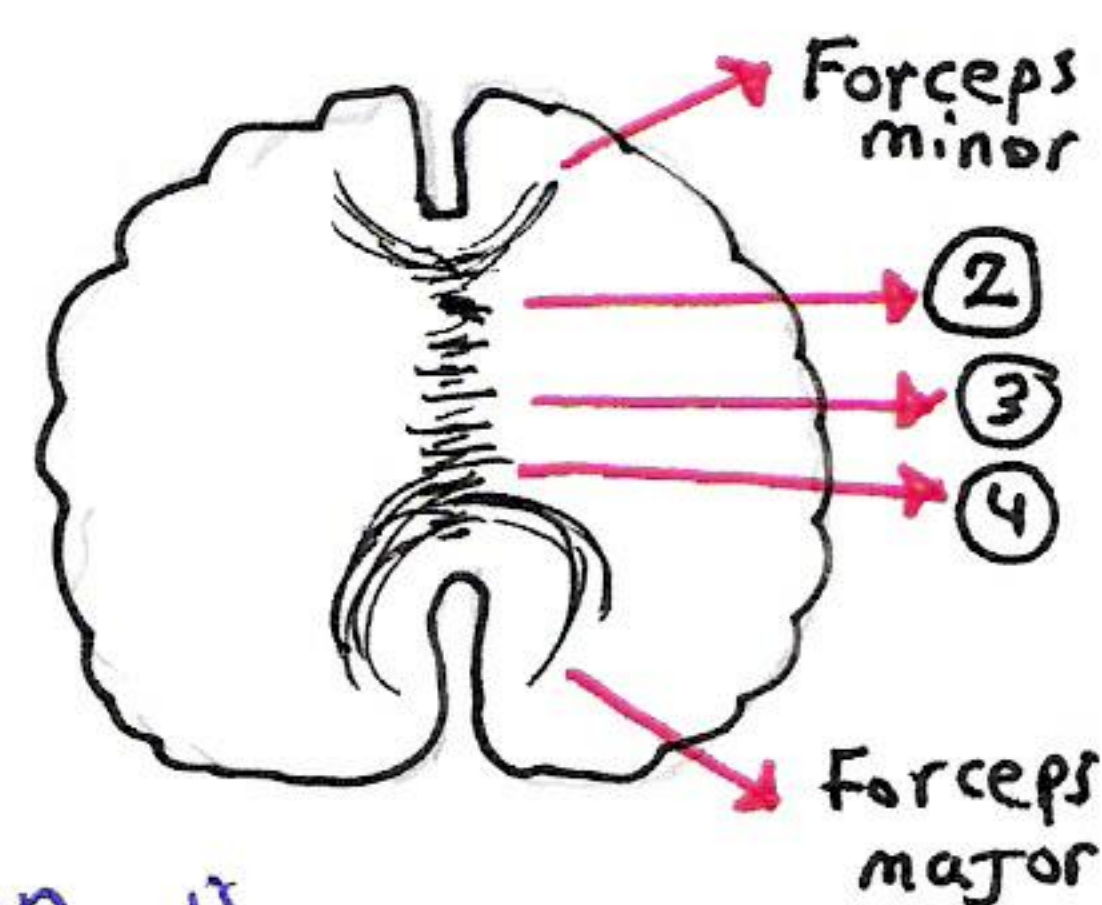
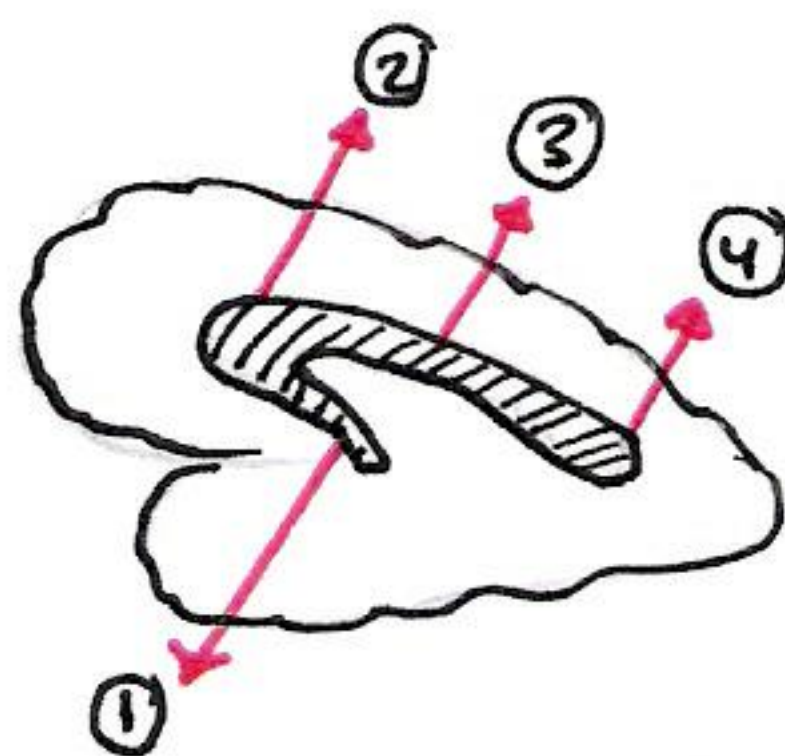
- ① Corpus callosum.
- ② anterior commissure
- ③ hippocampal commissure.
- ④ Posterior commissure → connect 2 sides of midbrain.
- ⑤ habenular commissure → between Rt & Lt nuclei of epithalamus.

* Corpus callosum :-

- the largest & main commissure of the brain
- connect symmetrical areas of 2 hemispheres (except temporal poles that have their own connection; anterior commissure).

* Parts of corpus callosum :-

- ① - rostrum.
- ② - genu
- ③ - body
- ④ - splenium



* Notes :-

- Corpus callosum is shorter retro-caudally than is the hemisphere, so fibers of c.c. that link the frontal or occipital poles are curved to form ant forceps (forceps minor) in frontal lobe & post forceps (forceps major).
- splenium connects occipital cortices (so contributes to visual ^{function} fnx)

* Ant. commissure :-

- runs transversely in front of ant. column of fornix.
- interconnect inferior & middle temporal gyri & olfactory region of 2 hemisph.

* hippocampal comm. :- (commissure of fornix).

- consists of transverse fibers linking posterior column of the fornix on each side.

III - Projection fibers :-

- Consists of afferent & efferent fibers of the cerebral cortex [connecting cerebral cortex to lower centers].
- afferent & efferent fibers from & to cerebral cortex are distributed radially as the corona radiata, then converge downward towards brain stem concentrated in narrow area called internal capsule

* Internal capsule :-

* Definition:- a broad lamina of white matter made up of projection fibers passing to & from cerebral cortex.

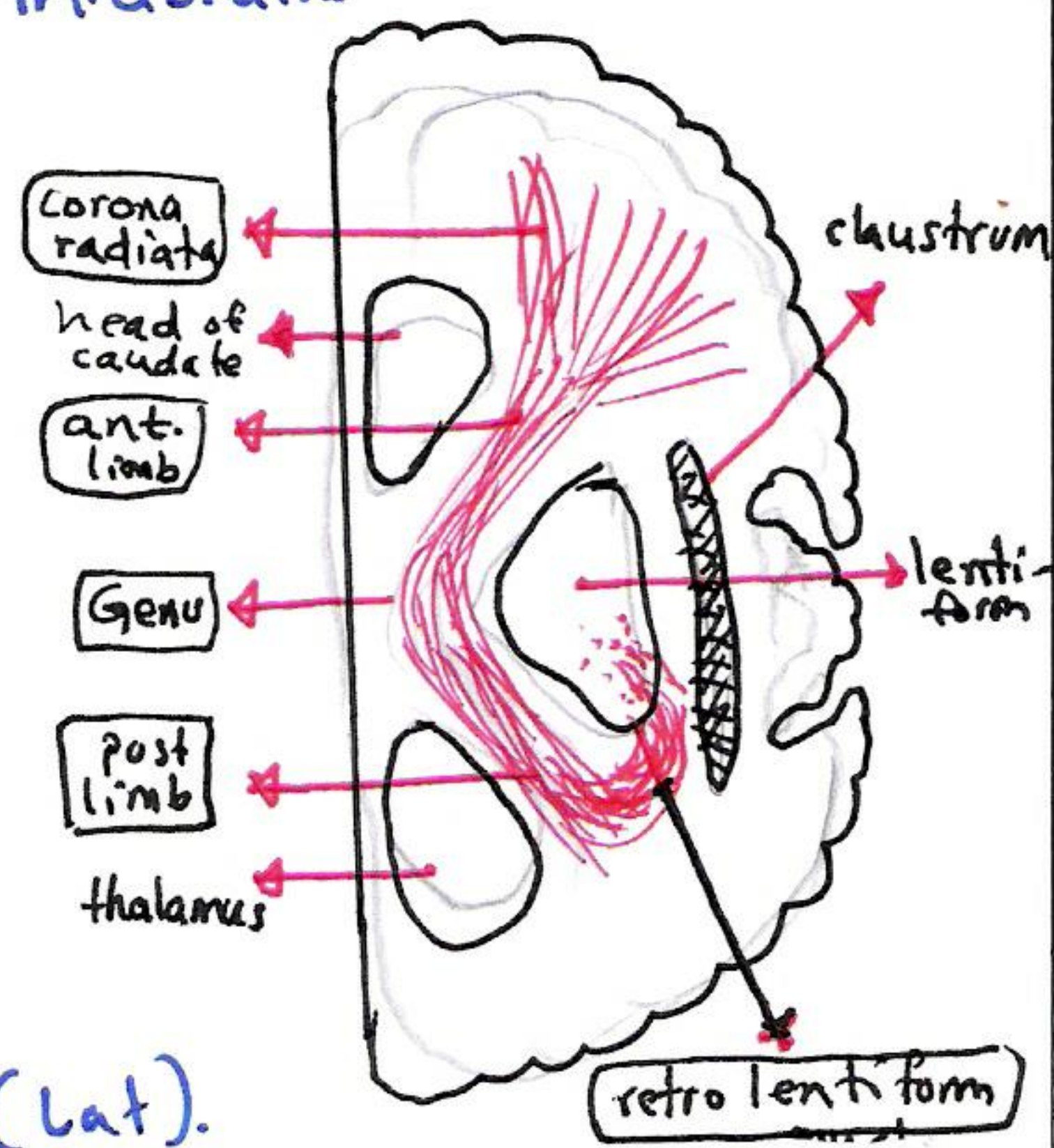
* Continuity:- continuous above with corona radiata & below with cerebral peduncle of midbrain.

* Site:- medial to lentiform nucleus & lateral to head of caudate & thalamus

* shape:- it is V shaped in transverse section with concavity laterally.

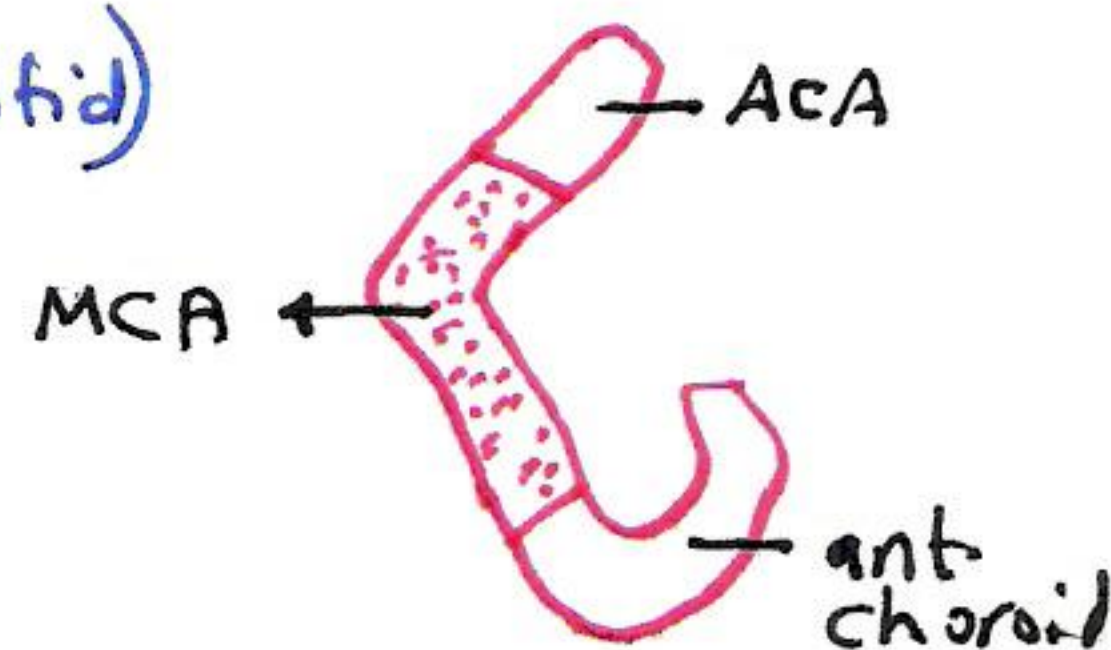
* Parts & relations :-

- ① Anterior limb:- short, lies between head of caudate (med.) & lentiform (lat).
- ② Posterior limb:- long, lies between thalamus (med.) & lentiform nucleus (lat).
- ③ Genu (apex):- angular junction between ant & post. limbs.
- ④ Retro lentiform part:- behind lentiform Nucleus.
- ⑤ Sublentiform part:- below lentiform nucleus.



* Blood supply :-

- ① ^{ant. part of} anterior limb → ant. cerebral a
- ② Post. part of ant. limb + genu + post. limb → middle cerebral a
- ③ retro & sublentiform → ant. choroida a (int. carotid)



* Types of projection fibers in internal capsule

	Descending tracts	ascending tracts
ant. limb	- Fronto-pontine fibers (from frontal lobe to pontine nuclei of pons)	ant. thalamic radiation (from ant. & med. thalamic nuclei to frontal lobe)
Genu	- cortico-bulbar fibers of pyramidal tract (from precentral gyrus to motor nuclei of cranial nerves)	
post limb	① cortico-spinal part of pyramidal T. ② Fronto-pontine fibers ③ cortico-rubral fibers	- sup. thalamic radiation
retro-lent.	parieto-pontine & occipito-pontine	- optic radiation (from LGB to visual area)
sub-lent.	temporo-pontine fibers.	- auditory radiation (from MGB to auditory area)

CRANIAL NERVES

■ Pure sensory nerves are: — ①, ② & ⑧.

■ Pure motor nerves are: — ③ (mixed by parasymp.), ④, ⑥, ⑪ & ⑫

■ Mixed nerves are: — ⑤, ⑦, ⑨ & ⑩

* Pure sensory N.

No.	Origin	pass through	Course
① Olfactory	• Olfactory mucosal cells → ≈ 20 olf. nerves	Cribriform plate	olf. bulb → olf. tract → temporal lobe (smell area).
② Optic	• Ganglionic retinal cells → optic nerve	Optic canal	Optic chiasma → optic tract → LGN (lat. geniculate body) → optic radiation → occipital lobe (visual area)
⑧ Vestibulocochlear	① Vestibular ganglionic cells in utricle, saccule & semi-circular canals ② Cochlear gangl. cells in cochlea	Internal auditory meatus	Vestibular nuclei in pons & medulla [equilibrium]. Dorsal & ventral cochlear nuclei in pons [hearing]

* Pure motor N.

No.	Origin	Point of exit	Course
③ oculo-motor	• Motor Nucleus (MB) at level of superior colliculus • Edinger-Westphal Nucleus (EWN) [Parasymp.]	front of MB enters into interpeduncular fossa	Passes between post. cerebral a & sup. cerebellar a → at lat. wall of cavernous sinus → Pass inside sup. orbital fissure (inside tendinous ring) → ① sup. division (SR & levator palpebrae superioris) ② inf. " (IR, MR & IO) : EWN → parasymp. (via inf. division) → sphincter pupillae & ciliary ms.
④ trochlear	• Motor Nucleus (MB) (mid brain) at level of inferior colliculus	back of MB	Passes bet. Post. cerebral a & sup. cerebellar a → at lat wall of cavernous sinus → Pass inside sup. orbital fissure (outside tend. ring) → SO
⑥ Abducent	• Motor Nucleus (P) (in pons) at level of facial colliculus	between pons & pyramid of medulla	Passes on clivus of skull → inside cavernous sinus (lat. to int. carotid a) → Pass inside sup. orbital fissure (inside tend. ring) → LR

(11)

accessory N.

- ① Cranial part:
• Nucleus ambiguus (in medulla)
② spinal part
upper 5 cervical nerve

- Medulla
between olive
& ICP
(inf. cerebellar
peduncle)

see page (16)

- A - cranial part
① pharyngeal br.
to phary. ms
(except styloph.)
② laryngeal br.
to laryngeal ms
C - spinal part
to sternomastoid
& trapezius ms

(12)

hypoglossal

- Motor N. (hypoglossal
nucleus) in Medulla

- Medulla
bet. olive &
pyramid

- emerge through hypoglossal canal
- then bet. ICA & IJV in carotid Δ
- then behind styloid & stylohyoid
& post. belly of digastric ms.
- Pass above hyoid Lat. to hyoglossus
& end inside tongue

- ① all ms. of the
tongue except
palato glossus
② by descends
hypoglossi (C1)
→ thyrohyoid &
geniohyoid

*Mixed nerves:

(5)

trigeminal

- ① Motor root
motor N. (in Pons)
• ② sensory root
- Main sensory N.
- Mesencephalic N.
- spinal nuclei of
trig. nerve

antero-
Lateral part
of medulla

- ① Sup. orbital
fissure
(ophthalmic)
② F. rotundum
(maxillary)
③ F. ovale
(mandibular)

see page
(29-32)see page
(29-32)

(7)

Facial

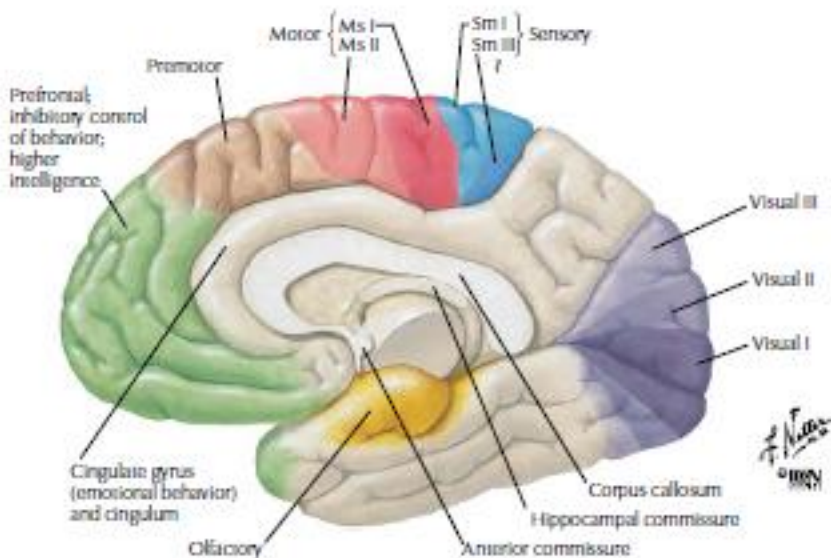
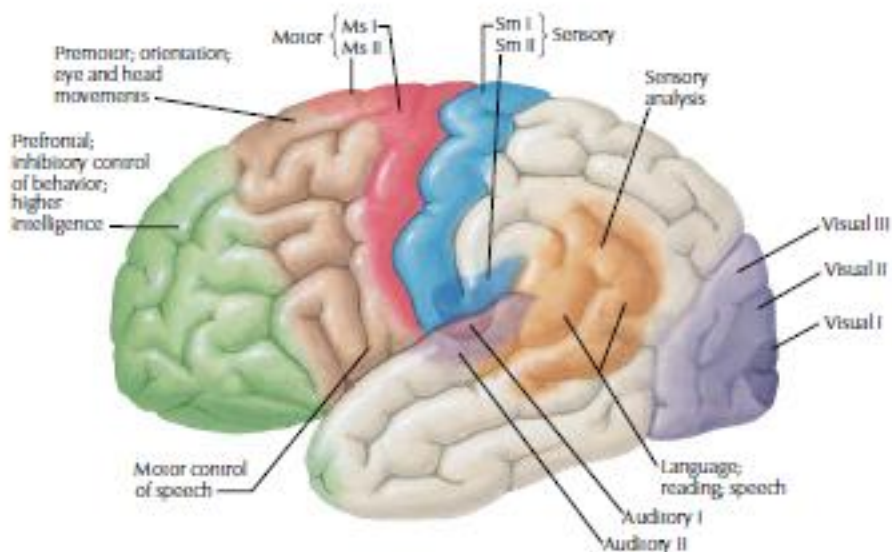
- ① Motor N. (pons)
② Nucleus
intermedius: carry
• Parasy → from
sup. salivary Nucleus
• taste fibres → from
nucleus solitarius

ponto-
cerebellar
angle

internal
auditory
meatus

enters middle ear
(medial then post. wall)
→ stylomastoid
foramen → inside
parotid gland giving
it's terminal br.

- A - intrapetrous part
(in middle ear)
1- greater sup.
petrosal N.
2- N. to stapedius
3- chorda tympani
B - at stylomastoid
1- N. to stylohyoid
(also to post.
belly of digastric)
2- Post. auricular N.
C - terminal (in gland)
temporal, zygomatic
buccal, Mandibular
& cervical



Handwritten signature and date: 11/11/11